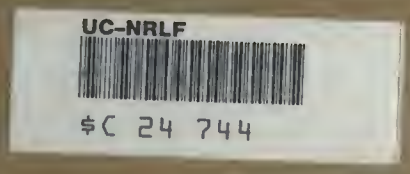
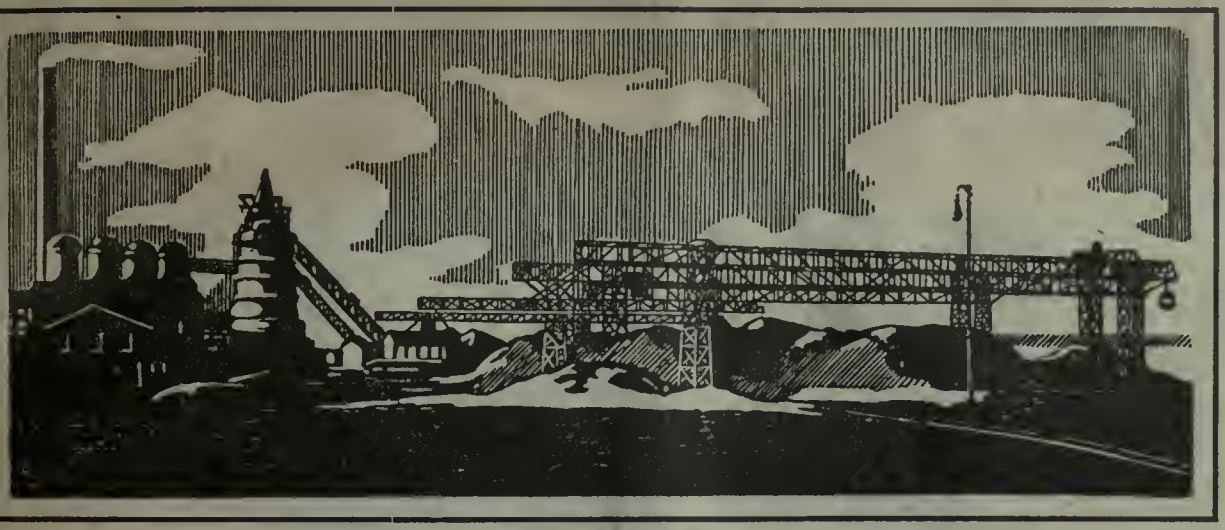
HC
287
R7S8
YF 01711





SKETCHES

FROM THE

RHINE-PROVINCE AND WESTFALEN

BY

EINAR SUNDT
EDITOR OF „FARMAND"
THE TRADE JOURNAL OF NORWAY

CENTRALTRYKKERIET :: CHRISTIANIA 1911

-2526-57

Gift of C. A. Kofoid

HC287
R758

THE INDUSTRIAL EVOLUTION OF THE RHINELANDS AND WESTFALEN IN THE LAST GENERATION

S

INTRODUCTION

In the spring of last year I spent a couple of months in Düsseldorf with the object of studying the industrial and economic development of the Rhine Province and Westfalen.

The result of my investigations will be found on the following pages. So far as I could discover, no attempt has previously been made to give a comprehensive description of the remarkable industrial evolution which has taken place in this district during the last forty years. My modest sketches do not pretend to give an exhaustive treatment of this great subject, but I have attempted to find expression for the admiration which I felt for the great ability, daring enterprize and indomitable pluck, which have in so short a time made these provinces the greatest industrial centre of modern Germany and one of the most important in the World.

Of those gentlemen who so readily gave me permission to visit their works and of others who in various ways assisted me in my studies, I beg that they will receive this book with my thanks.

Christiania, January 1911.

EINAR SUNDT.

HC287
R7S8

THE RHINE PROVINCE, WESTFALEN AND HESSEN-NASSAU

North of the South Western German highland stretches a comparatively low mountain plateau from the French frontier to Schlesien. Across the north-western corner of this plateau runs the Rhinish silur-mountain range: the Ardennes on the Belgian frontier, Hohe Venn, Eifel and Hunsrück on the left side of the Rhine; Taunus, Vogelsberg, Hessian mountains, Westerwald, Rothaar and Süder or Sauerland on the right side; isolated ramifications: the Teutoburgerwald, famous for the Herman Schlacht, Weser Bergland and Harz run into the lowlands to the north.

The Rhine with its affluents: Neckar, Main, Lahn, Sieg and Ruhr on the right side, Nahe and Mosel on the left, and the rivers Weser and Elbe with their affluents have cut for themselves deep and narrow beds through the plateau, and seen from the Rhine the landscape has therefore a very mountainous appearance. But from the «Höhe» or the hight, as the natives call it, the country appears more as a succession of undulating hills, fading away, one behind the other. Only occasionally are the hills more pronounced as for instance in the Siebengebirge with the well known Drachenfels, opposite Bonn, and this is accounted for by their volcanic origin.

The North German lowland is part of the extensive north of Europe lowland which stretches from the Pyrenees to the Ural. The German lowland runs from the northern rand of the Rhinish mountains to Holland, the North Sea and the Baltic; an arm of it bends southwards along the Rhine as far as to Bonn. This lowland is not everywhere flat, but along the Lower Rhine the land is an almost horizontal plain, stretching out of view on both sides of the river.

The climate of this district varies considerably. On the mountain plateau which is partially clad with pine forests, but partially very barren, the climate is bleak and in some parts there is a great rainfall. The valleys are, on the other hand, hot and dryer, and along the Rhine and its affluents, notably the Mosel, vine is extensively cultivated, an inheritance from the Romans.

The climate of the lowland is mild — at the time of writing, April 21st, the trees in Düsseldorf are a fortnight more forward than in Berlin, but not so advanced as in Paris. The summer and autumn are long, strong frost is almost unknown in the short winter. And as the soil of the lowland is generally very fertile, although there are here and there large tracts of heath, agriculture is extensively pursued.

The Süder or Sauerland and the Westerwald on the right side, the Ardennes and part of the Hunsrück on the left side of the Rhine are rich in iron ore. In the northern rand of the mountain plateau and also in the Saar (an affluent to the Mosel) district there are large coal measures, while there are extensive deposits of brown coals round Köln and Bonn, at Koblenz and in the Westerwald.

In the southern part of the district the population consists mostly of Franks, who live in the valleys by vine cultivation and trade; in the Sauerland the inhabitants are mostly Low German Westfalians who carry on mines, industry and trade. In the south of the lowland the population belongs mostly to the Middle German, in the north to the Low German race. During recent years there has been a large immigration, mostly of Polish, mining labourers.

On the whole, the inhabitants may be characterised as «gemüthlich» — jovial and cheery —, energetic and hardworking, with keen business instincts and plenty of pluck. The lower classes usually speak one or another of the many Platt or Low German vernacular dialects.

The lands which surround the Lower Rhine belong to those parts of Europe which may look back upon the longest period of culture. After Caesar had conquered Gallia in the years 58 to 50 b. C., it was his plan to continue his work by likewise conquering and Romanising the right bank of the Rhine, in order to make it a barrier against the attacks of the barbarians. His successor Augustus, less warlike and not a genius as Caesar, adopted a more modest and defensive policy, making the Rhine the eastern frontier of the Empire. This policy was folloved by his successor Tiberius, and although the Romans made several warlike incursions beyond the Rhine, they did not succeed in subjugating the German peoples; on the contrary, they suffered several crushing defeats at their hands, and the Rhine became the final limit of the Roman Empire against the East.

Remembering the remarkable power of the Romans to assimilate conquered nations, it cannot surprise to learn that a wealth of remains from this period has been discovered at Köln, the ancient Colonia Agrippina, which was the capital of the province. Ruins of a temple for Mercurius were found on the site of the Cathedral. In Trier, one of the most ancient of German cities, there are extensive ruins from the time when this place used to be a summer residence of the Roman Emperors, and the names of many places bear witness to the presence of the Romans.

In the middle ages Köln became one of the most important cities of Germany, because it was the See of the Archbishops. But as the many ruins of castles along the Rhine testify, these rich and fertile regions were overrun by a great number of petty sovereign magnates and marauding knights. These prevented, by their innumerable feuds and extortions, the district from reaching that degree of prosperity, which its rich and varied resources and the possession of that remarkable waterway, the Rhine, would otherwise have made possible. Among other effects of the disturbing influence of the landed aristocracy must be reckoned that the cities of Rhineland never flourished like the South German or the Hansa cities.

Coal mining in the Ruhr valley dates back to the 14th, in the Saar district to the 15th, at Aachen even to the 13th century. The iron industry of the Sauer district was already famous when the knights got their armour from the Iserlohn smiths and knives from Solingen. At Köln, the active commerce had called into life at an early time various trades and industries. In different districts various branches of the textile trades have flourished for centuries, especially in the Great Duchy of Berg, at Krefeld, Köln and other places.

But the Rhineland has in the modern era frequently been the seat of devastating wars; thus it suffered like the rest of Germany greatly from the 30 year's war, and the disruption of the Empire prevented her industrial development from making rapid strides. The many petty courts which imitated, in the 18th century, French civilisation have given to the Rhine-Province a number of fine Royal or Ducal castles and have created theatres and operas in all the towns which were at one time court residences; but this splendour was bought at far too dear a price, for the Princes thereby empoverished their subjects, and the high duties by which they filled their Exchequers crippled trade and enterprize. During the Revolution and the Napoleonic period the left side of the Rhine was incorporated with France and the districts on the right side, notably the Great Duchy of Berg, became vassals of Napoleon

After the downfall of Napoleon the Rhinelands fell to Prussia. In the beginning the bureaucratic rule, to which they were thereby subjected, did not prove beneficient to trade, and the terrible struggles had completely exhausted the country. Not before in the 30ties of last century could Germany begin to imitate the industrial improvements which had commenced in England in the closing decades of the 18th century. And in their start the infant industries were heavily handicapped by the disruption of the Empire which placed customs barriers to communication and commerce at the frontiers of all the many diminutive States into which the country was divided; and this division was carried to the extremest point just in the north western part of middle Germany. The industrial progress was therefore slow, and in the Rhinelands agriculture remained during the first two thirds of the 19th century the principal source of income and agricultural pursuits occupied the larger part of the population.

Gradually, however, a change took place. New methods of manufacture were adopted; the Rhine traffic was made entirely free in 1831; the railways were extended; the North German Zollverein which was established in the year 1834 greatly facilitated inland commerce; general and technical education was improved; all these and other factors contributed to the growth of industries everywhere and more particularly in the Rhinelands.

But here, like in the rest of the country, the war of 1870—71 marks the transition of Germany from an agricultural to a modern industrial country. The Rhinelands before and after the war differ so much almost, as if one had to consider two different countries; one may yet, so to speak, watch the process of this change taking place, by observing how the cities have altered. In Köln for instance, a modern city, two or three times as large as the old one, has sprung up outside the «Altstadt»; the fortifications have been demolished and in their place a splended Ringstrasse surrounds the old quarters with their narrow streets and crooked lanes. And the other leading cities, Düsseldorf for instance, have in a similar manner outgrown their narrow boundaries which had sufficed almost unchanged for centuries.

The character of the people has altered at the same time; instead of being careful to the extreme and rather narrowminded the business men of Germany, and particularly of Rhineland, have become almost American in their spirited enterprize and daring speculations. Because they have commenced only in so comparatively recent time to carry on their industries on a large scale and have had money enough, thanks to the highly efficient assistance of their banks, to build their new works and factories on very broad-minded lines, it is quite astonishing to learn how many big new works with splendid modern plants are to be found in this district.

The growing demand for labour has resulted in a rapid increase of wages, although they have not yet reached the English level, and taken as a whole the working classes seem to be well off; at least, I have seen nothing during my stay here which has even remotely resembled the depressing ugliness and squalor of so many working class quarters in English manufacturing towns. But living is very dear in the Rhinelands owing to the high duties, and I have been extremely surprised to find how relatively poor are the wages of engineers and of the educated classes generally.

This district which belongs, as I have already stated, to Prussia is divided into the Rhine Province, Westfalen and Hessen-Nassau.

The Rhine Province follows the Rhine on both sides from Mainz to Holland, its area is 27 000 km.^{2} Westfalen lies to the east of it, containing a part of the mountains, it stretches to Holland and Hannover; its area is about 20 000 km.^{2} And Hessen-Nassau lies in the heart of the mountains on the right side of the Rhine around the river Lahn; its area is 15 700 km.^{2}

The majority of the population belongs to the Roman Catholic confession.

The iron and coal and the engineering trades are the most important branches of industry; but the industries of the district are extremely varied and many other branches have reached a high degree of development.

Next to the iron and steel trade in importance comes the textile industry. The principal textile centres are: Aachen, Ahaus, Barmen, Bielefeld, Düren, Düsseldorf, Elberfeld, Eupen, M-Gladback, Kempen, Krefeld, Lennep, Mettmann, Montjoie, Neuss, Schwelm, Solingen and Wipperfurth. The textile industry has been carried on for centuries, but has been most rapidly developed in recent years; in 1895 the number of labourers employed in the textile industries was

Rhineland . . .	171 816
Westfalen	37 269
	209 085

while the total number in Prussia in the same year was 441 885.

Here as everywhere else the textile production used to take place in the homes of the labourers; in 1783 the first mechanical cotton spinning mill in the Rhineland was started in Crowford by Ratingen and thereby was given the signal for the modern development. Elberfeld—Barmen have held and still hold a leading position in the textile branch of the district; it produces silk goods, worsteds, furniture and carriage cloth, mixed fabrics such as Zanellas &c. Krefeld is the principal seat of the silk industry. In M-Gladback the cotton and mixed wool and cotton trades predominate, while the woolen trade which dates back to the 13th century flourishes in Aachen. Bielefeld produces linens. There are also a number of cotton producing towns in Westfalen. There are large cotton printing works and dyeing works in Elberfeld and other towns. In 1871—75 the average consumption of cotton per head of the population was 2.84 kg.; in 1896—1900 it had increased to 5.54 kg.

The confection industry, shoemaking and similar branches are well represented.

The chemical industries of Germany have obtained a pre-dominating position in the markets of the world; and these trades are very prominent particularly in the Rhineland. In another place I give a detailed description of the firm Farbenfabriken, vorm. Fried. Bayer & Co,; this is the largest firm in the colour trade in this district, but there are quite a large number of chemical industrial firms in this district in many different branches, for instance alcalis and acids, colours, paints, gunpowders, dynamite, artificial manures, white lead, zink white, &c. &c.

The paper making of this district is important both as to the quantities and as to the qualities which are manufactured.

The Rhine Province is rich in mineral springs and the output of natural mineral waters reaches nearly 80 million bottles per annum; the Apollinaris mineral water is used all over the world. The wine trade is a very important factor in the economic activity of the Rhine Province. But the consumption of beer is also enormous and there are several very large and a great number of smaller breweries in the district.

Sugar refineries, chocolate factories, flour mills, tobacco factories and many other branches of the food stuff producing industries are represented by large firms.

The stone, clay, porcellain and glass trades are carried on at many places; the saw mill and planing industry of Rhineland is very important, obtaining the raw wood either from the forests in the upper Rhine districts or from Scandinavia and Russia.

This list which does not pretend to be an exhaustive one will be sufficient to show the reader how very varied and highly developed the industries of this district are.

In 1902 an Industrial Exhibition for the Rhine Province, Westfalen and the neighbouring part of Wiesbaden was held at Düsseldorf. The districts which took part in this exhibition compare thus with the rest of Prussia.

	Exhibition district		Rest of Prussia.	
area	52 820 km.^{2}	15 %	295 790	85 %
population (1900)	9 955 414	29 %	24 517 095	71 %
property (1899)	23 430 600 000 Mk.	34 %	46 476 300 000	66 %
income (1901)	3 042 700 000	36 %	5 333 300 000	64 %
goods traffic on railways (1900) tons	97 445 735	45 %	117 159 296	55 %
cotton spindles (1901)	2 072 949	83 %	436 503	17 %
coal production (1900) tons	72 187 839	71 %	29 778 319	29 %
iron ore production (1900) tons	2 967 743	70 %	1 300 326	30 %
pig iron production (1900) tons	4 706 300	81 %	1 075 592	19 %
steel production (1900)	3 647 803	86 %	584 236	14 %

COAL MINING IN THE RHINE PROVINCE AND WESTFALEN

Coals and their use was known by the ancient Greeks; in a dissertation «on the stones» Theofrast who died 287 b. C. says, that the smiths employed stone coals, and in annals from the 9th century a. C. mention is made of the use of coals in England.

In his chronicle of Dortmund Detmar Mühler mentions the sale in 1302 of property in Dortmund to which appertained among other things «Kollengrafften» or coal quarries, and the use of coals for household purposes in the western parts of the Ruhr district is mentioned in 1317. It may therefore be assumed that coals were known and used to some extent even before that time. And a few decenniums afterwards they would seem to have become almost indispensible to the smiths. The production of coals remained, however, only a very moderate one in the district round the river Ruhr, being restricted to what the peasants could obtain by digging or quarrying from the strata which lay in the open near the Ruhr river. No attempt was made to undertake regular mining operations. Coal quarrying was classed with stone quarrying, and coals were considered as not falling under the concession rules that regulated mining proper. From this reason there are no records up to the 16th century of the coal production in the Lower Rhine and Westfalen districts.

From about 1500 records, however, become sufficient to show that coal mining was developing. The diminishing wood supply was a contributing cause, but in the main it was due to the growing importance of the iron industry in the neighbouring Sauer district. The town Iserlohn had by that time already become famous on account of her armourwork, Altena for wire making, Solingen for knives and forks, not to mention other places. The products from the workshops of these towns found their way to markets over the sea, as Scandinavia and England, through the flourishing trading towns of Dortmund and Soest which benefited by belonging to the Hansa.

In 1598, however, Spanish troops broke in over Rhineland and Westfalen; on the death of the last Duke of Jülich-Cleve there was a long succession war, and shortly afterwards the 30 years' war broke out. At the close of nearly 50 years of almost continuous wars the country was devastated.

The legal status of the coal mining industry had been unsettled. When, by the Xantener treaty of 1614, the Mark became Prussian, the mining regulation of 1542 was republished in 1639 and applied to coals also, and trained mining experts were called in. Under the Great Kurfürst mining and allied industries received many privileges. But still more important was the revision in 1737 of the mining regulations and the establishment of the Märkische Mining Board at Bochum in the following year. From this date may be reckoned the commencement of regular mining operations in the Ruhr coal fields. The legal status of the mines was settled, capable mining officials were appointed and the importance of sinking deep pits was recognised.

Friedrich the Great worked with all his energy for the progress of the mining industry. In 1766 he issued a revised mining regulation and he created a better outlet for the produce of the coal mines by constructing good roads and by making the river Ruhr navigable, the latter task was finished in 1780. In 1792 the Westfalen Mining Board was established, the seat of which was afterwards removed to Dortmund.

By the Peace of Luneville of 1801 the Essen-Werden district became Prussian; the County of Dortmund was occupied by Prussian troops in 1813 and the Prussian mining regulations of 1766 were at once introduced into these districts.

While the coal winning had at first been restricted to the exploitation of those coal strata which lay in the open, the mines were gradually worked deeper and deeper, but, as a consequence, the difficulty of keeping them free from water greatly increased. This led to the opening of Stollen or levels, running from the bottom of the valley in to the coal seams in order to draw away the water. The old difficulties were, however, again encountered as soon as the pits were sunk below the level of the bottom of the valley. At this juncture the steam engine saved the situation. At the coal mine Vollmund which is still worked the first steam engine in Germany was erected, in 1799. As it turned out a great success, the number of engines soon increased. Twenty years afterwards there were 20, after another twenty years 95, and in 1850 already 123 steam engines were in use at the mines of the district. The employment of the steam engine has done very much to make the coal mining industry flourish, as it made it possible to use deep pits. And deep mining became a necessity, when the industry had to be extended from the Ruhr mountains to the plains in the North which were partly covered by Mergel (marl) and where horizontal Stollen or levels could not be used.

The opening of railways and the rapid development of the iron industry have, however, been the main factors of the recent enormous growth of the coal mining industry of this district. This is evidenced by the fact that more than 90 % of the coals which are produced, including the cokes that are made at the mines, are nowadays transported by rail.

The State has contributed to the prosperity of the coal industry by a number of laws for lightening its burthens, regulating the work and providing against mining disasters. It must be particularly emphasized that the Gewercke (the companies owning the mines)

have been given a free hand as to the management of the mining operations, sales &c.

The following figures show the growth of the Lower Rhine—Westfalen coal mining industry.

	Number of works.	Production tons.	Number of workpeople.	Per workman tons.
1792....	154	176 676	1 357	130
1800....	158	230 558	1 546	149
1810....	177	368 679	3 117	118.5
1820....	161	425 364	3 556	119.6
1830....	172	571 434	4 457	128.6
1840....	221	990 352	8 945	109.5
1850....	198	1 665 662	12 741	130.7
1860....	281	4 365 834	29 320	148.9
1870....	220	11 812 528	51 391	230
1880....	202	22 495 204	80 152	270.6
1890....	177	35 469 920	126 794	277.5
1900....	167	59 618 900	226 706	263
1908....	162	82 664 647	334 733	247
1909....	163	82 803 676	340 567	243

Besides in the Ruhr district coals are also produced in the Saar district and at Aachen. The Saar coal measures extend over the most southerly part of the Prussian Rhine Province and over the neighbouring parts of Pfalz and Lothringen. The first records of the presence of coals in this district is contained in «Schöffen-Weistum von Neumünster» of the year 1429, where it is stated that the «steyenkolen» are part of the regale of the territorial ruler.

The development of the industry was similar to that of the Ruhr district. It was not until the second part of the 18th century that the declining wood supply caused a proper mining industry to be started, but until far into the 19th century this industry was carried on by a number of individually quite small concerns. After the rapid industrial development had commenced and railways had been started the coal industry on the Saar measures has also flourished. But while the mines in the Ruhr district belong, with a single exception, to private companies, the Saar mines belong, with unimportant exceptions, to the State. In 1751 all the mines which had hitherto been worked in a ruinously wasteful manner were made, with the consent of the owners, State property and worked by the fiscus of the territorial Sovereign.

The following figures give the growth of the coal industry in the Prussian part of the Saar district.

Year.	Number of works.	Production tons.	Number of workmen.	Per workman tons.
1820....	—	115 341	—	—
1830....	—	223 191	—	—
1840....	—	408 138	—	—
1852....	30	770 369	6 804	113.2
1860....	25	2 020 265	12 757	158.6
1870....	15	2 785 549	16 208	171.8
1880....	13	5 297 554	23 628	224.2
1890....	14	6 389 405	28 866	221
1900....	13	9 126 788	39 693	229.9
1908....	13	11 223 045	51 998	216
1909....	13	11 220 919	53 858	208

At Aachen there are two smaller coal measures, situated close to each other, the Inde and the Wurm districts. Here coals were won as early as in the 12th century. After having been carried on by a large number of small owners the industry was consolidated in the middle of the 19th century and has increased rapidly as a consequence.

The progress of this industry is indicated by the following figures.

	Number works.	Production tons	Number of workmen.	Per workman tons.
1852....	20	410 840	3 447	119
1860....	19	610 610	4 951	123.3
1870....	19	893 526	5 133	174
1880....	17	1 194 115	5 388	221.6
1890....	14	1 484 784	6 609	224.3
1900....	10	1 764 398	7 964	221.5
1908....	16	2 385 986	11 365	201.1
1909....	12	2 566 313	12 744	201.4

THE IRON AND STEEL TRADE OF THE LOWER RHINE PROVINCE AND WESTFALEN

In the Lower Rhine Province and Westfalen the iron trade dates back to about 1750, at which time the first small blast furnaces for producing charcoal iron were started in the Ruhr district; but the trade increased only slowly during the first hundred years. The moderate quantities of ore required in the infancy of the trade were obtained locally as Razenersz or bog iron ore.

When freshing and hammer works were started, about 1812, it became necessary to obtain pig iron from the Middle Rhine and Lahn districts. About 1835 puddling works were started, for which the pig iron was imported from England and Belgium; it marked a great progress in the industry, when, towards the middle of last century, the first mill for rolling rails, rods and plates was started by the Gutehoffnungshütte.

The year 1844 may be regarded as the turning point in the history of the trade. In that year an import duty was placed by the Zollverein upon foreign pig iron, and about the same time the production of coke of Ruhr coals was commenced. The production of pig iron was thereby so rapidly increased that the local supply of iron was no longer sufficient, and the iron works had to rely more and more upon ore from other parts of Germany or imported from abroad. And in order to be independent of the market for their supply of coals the iron works commenced to acquire coal mines. The Ruhr river became gradually superseded as the main communication from this district by the railways and since 1870 the connection between the mines and the Rhine has depended almost exclusively upon the railways.

There had thus been a steady development in the iron trade, but it had not reached large dimensions before the great dividing line in the destinies of the German nation was drawn by the Franco-German war.

During the closing centuries of the Middle Ages the other States of Western Europe became strongly centralised, because the monarchies of France, Spain, England and the Scandinavian Kingdoms succeeded in gaining the ascendancy over the landed aristocracy and obtained more or less absolute power by placing themselves at the head of the national aspirations of their various States.

In Germany only this centralising process did not take place; the Empire — das Römische Reich deutscher Nation — always remained elective, while the hereditary principle became general in the other European States. This and the futile connection with Italy weakened by degrees so much the power of the Kaiser, that in course of time the country became split up into a large number of practically independent petty States in which the principal families of the Hochadel obtained full sovereignty.

The authority of the Emperor, reduced frequently to a mere shadow, was for long periods not sufficient to keep peace and protect commerce within the country, which was often disturbed by wars between the States or by marauding Knights. And although the Hansa towns and some of the cities in the South, notably Nürnberg and Augsburg, flourished, the economic progress of Germany as a whole was greatly retarded for centuries in comparison with her neighbours, who possessed the strength of national union which Germany lacked.

To the political disruption which was an heritage from the middle ages was added at the beginning of the Modern Era religious dissensions and the terrible devastation of the 30 years' war.

Under such conditions one cannot wonder that the Fatherland did not, in the 16th, 17th and 18th century, progress, economically and industrially, at the same rapid rate as for instance France and above all England. The German Imperial Crown had become, under the Habsburgs, united iwth that of Austria, and during the closing decades of the 18th century the German nation sank to the lowest point in her destiny, for at that period the innumerable petty Sovereigns had usurped absolute power and vied with each other in imitating to the best of their ability the immorality and the luxuries of the Court of Versailles, wasting in this vain attempt the savings of their subjects, and the centre of gravity was in Vienna, outside the borders of the German Empire proper. The small States became more and more completely crystallized, making inland commerce very cumbersome, and the Empire was too weak, even if it had been willing, to give German traders sufficient protection in their ventures abroad.

Only in Brandenburg, afterwards the Prussian monarchy, there was a slow, but steady commercial and industrial progress under the enlightened rule of the Great Kurfürst and his successors, above all Friedrich the Great, and enlightened patriots who lamented the impotency of their Fatherland began to look to Prussia as the coming saviour of Germany.

The Revolution and afterwards the Napoleonic wars commenced at the very time when the modern industrial era had been ushered in by the many brilliant mechanical inventions that had been almost simultaneously made in England; different spinning and weaving machines, the steam engine, the coke method

of iron making, the crucible steel process and other similar inventions were all made between 1760 and 1790. These inventions could at once be fully utilized by England, although she was almost continuously for more than 20 years implicated in wars, because she was protected by her navy. Germany, on the other hand, was constantly the very seat of the war and she was thereby effectively prevented from attempting to imitate the example of England and from making use of the many new mechanical appliances for increasing her industrial activity. And by the end of the Napoleonic period Germany was too exhausted to try to enter at once into industrial competition with England. It was not before towards the middle of last century that Germany could commence her industrial career, and England had thus a start before her of about 50 years.

Napoleon was, however, for Germany like a tempest in the autumn that blows down all the dry leaves. A large number of the petty Sovereigns disappeared, never to return, and what is still more important, musty opinions and timeworn fetters upon individual thought and freedom of action had been swept away, and new ideals and bright hopes had been born to life during the national struggle against the Colossus. These ideals which had their roots in the deepest and finest aspirations of the German mind could not be killed even by the biting frost of the Holy Alliance and the reaction that set in after Napoleon had been beaten at Waterloo. It fell to the lot of Prussia, probably because her people are the least romantic and the most hardworking of the Germans, finally to convert through the «Blut und Eisen» policy of Bismarck the romantic and somewhat hazy dreams of the German patriots into hard facts. Among the many steps taken by Prussia to prepare for the supreme struggle, not the least important was the forming of the North German Zoll-Verein, for this was the indispensible condition for the evolution of a national industry. As Prussia was already the most populous, she became thereby also financially the strongest of the German States. And this enabled her citizens to bear the heavy burthens which the policy of Bismarck demanded.

On the battle fields of France 1870—71 the wisdom of this policy was abundantly demonstrated, The loftiest dreams which the best sons of the Fatherland had cherished for centuries were consummated, when Wilhelm I was proclaimed in Versailles, on January 18th 1871, the Kaiser of the Germans.

It is no wonder that the heros of that memorable war, the Emperor and his great Chancellor, with their generals and soldiers, are honoured with statues in every German city, for are they not personifications of German valour and German ideals? But what is much more significant is that the enthusiasm which created the unification of Germany, is as much a living force to-day as when, 40 years ago, it carried the war to a successful issue.

Trade follows the flag, is an English saying; it is as true of the Continent as of the English island kingdom. The disruption of the Fatherland into a number of small independent States had made the evolution of a large national commerce and industry impossible; with the establishment of the Empire followed the extension of the Zoll-Verein to all the States and all the fetters on inland commerce were thus swept away.

Intoxicated by the belief in the might of Germany which was engendered by the successful war and — by the milliards which France had to pay, the German nation was carried away into a speculative mania, that spread to all countries, the like of which the World has not afterwards witnessed. What had been gained on the actual field of battle should be emulated on the peaceful battlefield of commercial and industrial competition.

Nowhere, perhaps, did the people throw itself with such a ferocious energy into this economic struggle as in the Rhine Province and Westfalen. The immense coal resources of the Ruhr district were recognized as forming the basis upon which a gigantic iron industry with all which that implies might be built up, and with feverish haste existing iron works were enlarged and new ones created.

But the speculative bubble, the wild Hochkonjunktur, which followed the peace, did not last more than a very short time; in the autumn of 1873 the Krach in Vienna gave the signal, as will be remembered, for the unavoidable reaction, and the trade of the World suffered from an intense prostration until 1881—82. And the iron industry of the Ruhr district had to bear to the full its part of the depression which was a result of the previous overspeculation. Technical mistakes could not always be avoided when extensions of old works or the building of new ones were hastily planned; and above everything, the production had been enlarged far too rapidly, and on a falling market the Rhinish makers were cruelly undersold by English and Belgian producers with whom they were as yet unable to compete, and the trade had to pass through some years of the most terrible sufferings, verging upon complete ruin. It is characteristic of this period that in 1878 Gutehoffnungshütte was compelled to write down its capital from 30 Mill. Mk. to 6 Mill. Mk.

At this critical juncture, in 1877—79, Bismarck came to the assistance of the national industries with his protective system. It is, at any rate, the opinion of those Germans with whom I have discussed the subject that the marvelous growth of the German industries during the last 30 years must be attributed to the Wirtschafts policy inaugurated by Bismarck. A duty of 10 Mk. pr. Ton on pig iron was imposed, the same which still prevails, and so the inland market was preserved for the German makers.

Personally, I am not convinced that this is the true explanation of the matter. At about the time of the greatest depression in the iron trade, in 1878, an invention was made by the Englishman Thomas,

which has had the most far-reaching influence upon the German iron and steel industry. Sir Henry Bessemer had invented in 1855 the process for converting pig iron into steel or forge iron, which bears his name. After some years of experiments his method was perfected and it was followed by a most remarkable increase in the world's output of steel. The Bessemer method was first introduced in Germany by the Hoerder Verein in 1864. But the Bessemer converter had this drawback that its lining with acid fire proof material did not permit of purifying the iron of its contents of phosphor, and it was therefore necessary to use only phosphorfree pig iron. While England possesses her famous haematite ores, Germany is comparatively poor in phosphorfree ores and had to import, for the production of Bessemer steel, either English pig iron or Spanish ores.

The Thomas basic process is an adaptation of the Bessemer converter for iron with a great percentage of phosphor. And when this method had been perfected, it gave the German iron makers the possibility to increase their output so rapidly during the last 30 years as has been the case. The production of pig has been

	Germany tons	Gt. Britain tons
1865	975 000	4 896 000
1875	2 029 000	6 432 000
1880	2 729 000	7 802 000
1890	4 658 000	8 033 000
1900	8 422 842	9 051 107
1901	8 521 000	9 052 000
1902	7 880 000	7 886 000
1903	8 403 000	8 654 000
1904	10 086 000	8 952 000
1905	10 104 000	8 700 000
1906	10 988 000	9 746 000
1907	12 478 000	10 311 000
1908	11 813 511	9 438 477
1909	12 917 653	9 818 916
1910	14 793 325	—

The enormous importance of the Thomas and the basic Siemens-Martin processes for the recent development of the German iron and steel industry may be seen by the following comparison of the steel production of the principal countries in 1904:

	Bessemer tons	Thomas tons	Bessemer-Thomas total tons	Siemens-Martin acid tons	Siemens-Martin basic tons	Siemens-Martin total tons	Grand total tons
U. States	7 982 886	—	7 982 886	814 120	5 188 069	6 002 189	13 985 075
Germany	423 742	5 525 429	5 949 171	130 546	2 697 760	2 828 306	8 777 477
Gt. Britain	1 147 292	662 746	1 816 038	2 624 615	672 657	3 297 272	5 113 310
France	—	—	1 334 798	—	—	745 556	2 080 354

This perfection of technical processes which have proved themselves in a high degree suitable to the natural conditions under which the German iron industry is carried on, has no doubt been the main cause of the marvelous growth which has taken place in the German output of iron and steel since Bismarck introduced the protective system. The progress has taken place *post hoc*, but not necessarily *propter hoc*.

The explanation of the improvement as being due mainly to the protective system seems to me also to underrate the influence of the admirable technical education of the German nation. It is true, that the first modern technical high schools had been established as early as in 1840 to 1850. But experience from other countries, Norway among others, proves, that one has to wait sometimes rather a long time, before the influence of the education given in such schools makes itself fully felt in practical life, and besides, the technical schools of Germany were only slowly multiplied and had probably not at once reached their present high degree of perfection. And the banking system, as it is to-day practised in this country, which has undoubtedly contributed very largely to the industrial development, was only in its infancy at the time of the war. Above all, when the war was ended and those political objects attained which previously had consumed most of the thoughts and efforts of the nation, the energy was suddenly focused on economic matters. Historical and accidental causes had hitherto prevented the activity of the people from being directed to large commercial and industrial undertakings; when these barriers were at last broken, the pent-up energy burst forth with torrential power, and the result has been that phenomenal expansion of banking, commerce and industry, which characterises modern Germany as a whole and not the Rhinish-Westfalian iron and steel industry only.

It is in my opinion to the sudden application to business of this accumulated energy and to her rapidly growing wealth, much more than to the protective system, that Germany owes her present dominant industrial position.

The protective duty was no doubt very welcome to the owners of the iron works at the time when it was introduced, because they were not yet able to meet the foreign competition on equal terms, but it has also been accompanied with an all round increase in the cost of living.

Be that as it may, however, it is certain that after protection was introduced, the Rhinish—Westfalen iron and steel industry has been constantly developed, not only in regard to the quantities produced, but

quite as much in regard to the efficiency of the iron and steel plants and the quality of the goods that are produced. An expert, with whom I discussed the matter, told me that he had last year visited several English steel works and he had been much surprised to find how much they were behind in their plant as compared with the works here. As a result the Rhinish iron and steel industry is to-day very largely based upon export and seems to be fully able to meet the competition.

The growth of the iron and steel trade has caused a number of engineering firms to specialize as makers of mining machinery, plants for blast furnaces and steel works, and cranes for the discharge of coals and ore. These last named firms have contributed greatly to the progress of the iron trade, because it has become essential that the discharging of the ore of the sea ports and in the Rhine harbours should be done inexpensively, as it is actually done by the modern discharging arrangements. The local engineers stimulated by this local requirement have thereby become large exporters of cranes of all sorts to every part of the world, and there are a number of engineering firms who do an extensive export trade in hydraulic, mining and other kinds of heavy machinery and in boring tools.

The large coal trade, the iron and steel trades built up on the coal supply and the allied engineering trades have during the last 30 years felt, like the rest of the world, the influence of the recurring waves of good and bad trade, but these staple industries of the district have been so constantly and rapidly developed during the past generation that one has to go to the United States to find a parallel to the rapidity with which the progress has taken place in this district.

The number of labourers required by the rapidly increased production has grown so fast that the district itself could not supply enough, and a large part of the labourers, particularly in the coal mines, are therefore immigrants, mostly Poles. Wages have gone up considerably; for unskilled labourers it is, I believe, as high or higher than in England, but for skilled labourers the rates are not yet so high as in England. It must, however, not be forgotten that owing to the high duties the cost of living is considerably higher in Rhineland than in England.

The Thomas process is peculiarly well adapted for production of great quantities, and this has led to the concentration of the Thomas steel production in the hands of a comparatively small number of large undertakings of which some are of gigantic proportions. About 95% of the entire steel output in Germany has become centred in those 36 steel works who to-day form the Stahlwerksverband. The balance, exclusively open hearth steel, is produced by those Siemens-Martin works which are still outside of the Verband.

The capital required for the immense modern steel works was much more than individuals could command, and the Limited Companies, and thereby also the large capital of the banks, gradually obtained a preponderance. The number of small concerns was successively reduced, partly by closing down. The number of puddling works decreased from 321 in 1884 to 147 in 1903.

And at the same time another movement took place; the great works became »mixed», viz., they tended more and more to comprise all stages of the manufacture, iron and coal mining, blast furnaces, rolling mills and finishing works. As a consequence the socalled «reine Werke», which either produce only pig iron, or rolling mills which buy their half manufactured steel, have to fight a hard fight for their existence. For the mixed works are able to produce at a considerably lower cost. Not only is the percentage of their general expenses less but the mixed works have also great technical advantages. While there are other districts in Germany where there are only large mixed works, there are in the Rhine Province and Westfalen district all kinds of undertakings, from the smallest to the largest modern mixed works.

The German production of pig iron in 1905 was divided between the various districts as follows:

	tons	%
Rhineland, Westfalen	4 376 640	39.8
Siegerland, Lahn, Hessen-Nassau	710 643	6.5
Schlesien	861 012	7.9
Pommern	155 880	1.4
Hannover & Braunschweig	370 960	3.4
Bayern, Würtemberg, Thüringen	177 481	1.6
Saar district	874 310	7.4
Lothringen & Luxembourg	3 520 697	32.0
	11 047 623	100.0

Competition frequently forced selling prices below cost of production, and the first attempts to counteract this evil by organisations among the makers, price agreements and the like, were made about 50 years ago. In the whole German iron trade there exist at present nearly fifty associations. At first their objects were mainly the collection of statistics, agreements as to selling conditions and similar matters, but gradually they commenced fixing the selling prices, and finally many of them were transformed into «Kartels» or «syndicates» which regulate the output of their members and undertake the selling of their products. The earliest of these was the *rheinisch-westfälische Roheisensyndikat in Düsseldorf*, formed in 1897, with a sale office for selling in the home market, since 1904 for export also. The first *Halbzeugverband*, or half manufactured steel association, was established 1 Janr. 1899 in Düsseldorf, and at the same time the *rheinisch-westfälische Trägerverband* or girder association was started; besides these great Verbands there are a large number of similar associations for various specialities.

With the object of securing as much as possible stability in production and selling the *Stahlwerksverband* was established 1 March 1904 by the mixed works who produce half manufactured steel, formed iron and rails. This association has 36 members. Each mem-

ber has been assigned a «Beteiligungsziffer» and according to the state of the market the Verband from time to time fixes the percentage of the combined producing capacity of the associated works which is actually to be used. The Verband buys of its members their output of the socalled Produkte A: rails, girders etc., while the works themselves sell their so-called Produkte B: rods, plates, tubes, railway tyres etc. The Verband pays the works monthly a price which about equals the cost and divides the profit annually pro rata. If a member has sold more B products than its Beteiligungsziffer warrants, it must reduce its delivery of A products to a corresponding degree, and if the members enlarge one part of their works they must reduce the output in some other branch. But beyond this control of the price and the production the Verband is not extended; the Works are technically and commercially managed quite independently by their owners.

The coal mines have formed a similar organisation the *rheinisch-westfalische Kohlen Syndikat* in Essen.

As these different Verbands have to meet the competition of the world, when exporting, they must fix their export prices accordingly, but, being protected by the duties in the home market, their prices are frequently higher for inland consumers than the export prices.

The rapid progress of the coal mining and the iron and steel industry has created enormous wealth in the Rhine-Province and Westfalen and the population has also increased rapidly.

THE SHIPPING ON THE RHINE

No doubt, the noble Rhine has been one of trade's great highways ever since Europe became inhabited. In the Roman era there were several important towns on the banks of the river, notably Colonia Agrippina (Köln). But in the middle ages, when the power of the German Emperors declined, the territorial magnates in the countries through which it flows, usurped the right to exact duty of the commerce that passed on the river, and at one time there were not less than 30 customs houses for collecting this Rhine duty between Germersheim and Rotterdam.

Among the magnates who claimed the right to levy such duty, were also the Archbishops of Köln. Their customs house used to be at Neuss, opposite Düsseldorf. But in the middle ages the Rhine frequently changed its course and in the 14th century the river left Neuss. The Archbishop Friedrich III, a Count von Saarwerden, therefore removed, in the first years of his reign (1370—1380) his customs house to Zons, a few kilometers above Düsseldorf, and at the same time he rebuilt the Tower at that place, which had been pulled down by the citizens of Köln during an insurrection against the Archbishop about a hundred years previously, and the village of Zons which was at the same time raised to the dignity of a city, was fortified.

The fortification was done in a substantial manner by the same class of architects who built the cathedrals, and although the main tower has been destroyed, the walls remain and are mostly well preserved. All but 5 of the original houses were, however, destroyed by a conflagration in 1620 and were rebuilt in poor style.

The annual income of the Archbishops from the duty, levied at Zons, is said to have reached 5 000 Gold ducates, a very big amount in those days, and for a long time the city was of great importance as a frontier stronghold against the hereditary enemies of the Köln Archbishops, the Counts von Berg.

About 1767 the collection of the duty at Zons was discontinued and the Rhine free from customs duties, and the place had gradually lost all political importance, since the citadel was destroyed by the Hessians in 1650. Besides, the city had never benefited by being the seat of this customs house, nor had it ever obtained any commercial importance, and, finally, it has also become sanded up like Neuss previously.

A visit to this little place which has, as it were, slept for centuries, is a very curious experience. It is like walking from a spick and span modern Prussian town, with its broad, asfalt paved streets and treeplanted avenues, its Schutzmänner in pickle helmets &c., to find oneself transplanted into the middle ages, 5 or 600 years ago, when the Warden of the Archbishop's castle worried the traffic on the river with his demand of a heavy duty.

To go right away from Zons to the modern, up-to-date harbours of Düsseldorf or Duisburg-Ruhrort,

what a contrast! And yet it is the same majestic Rhine which passes sleepy Zons, that fills these great harbours with their bustling traffic.

Since the shipping on the Rhine which had been almost killed by all the burthensome customs barriers, was again made free in the closing decades of the 18th century, it has been constantly growing; and after the formation of the modern German Empire in 1871 it has increased by leaps and bounds until it has now reached gigantic dimensions.

According to tradition the middle Rhine vessels in the 15th century which were mostly used for goods transport had a loading capacity of 1200 to 1500 Cwt.

In the 16th and 17th century the type became more like the modern one.

For the city of *Ruhrort* which has always been the chief place for Rhine shipping it was of the utmost importance that the river Ruhr was made navigable about 1770. The trade route to Holland which was thereby opened made the evolution in the years 1770 to 1790 of the mining industry in the Ruhr district possible. The coals were transported to Ruhrort exclusively by the river in so called «Ruhrnachen» until the opening of the railways. The Ruhrnachen were built of oak and carried 2 000 to 3 000 Cwt. being 38 to 40 m. long, 5 m. broad; empty they drew 54 cm., and loaded 1.30 to 1.40 m. of water.

The Rhine vessels of that thime for coal transport, called «Rüderchen», were also of oak and could take cargoes upwards of 4000 Cwt. They were somewhat larger in all dimensions than the Ruhr vessels and drew 1.70 to 1.80 m. water when loaded. For the sake of the Rhine dues they were all registered.

In the middle ages sails played an important role on the Lower Rhine. If there was no wind, the vessels were drawn by men or horses. A journey from Köln to Mainz took 55 to 80 hours for a vessel with a cargo of 2000 Cwt.

A new epoch commenced for the Rhine shipping when steam was introduced. The first steamboat was seen on the Rhine on June 12th. 1816. It came from Rotterdam and made the journey to Köln and back in 5 to 6 days. It was followed by more steamers, built for both passenger and goods traffic. The regular traffic on the Rhine by steamers dates from the 20ties. In 1829 a Dutch company placed a steam tug on the river for towing vessels between Rotterdam and Köln, but the financial result was poor. It was only in the beginning of the 1840-years that really the shipping by steam towing was properly developed by the firms Franz Haniel & co. in Ruhrort and Math. Stinnes in Mülheim a. d. Ruhr. The steam tugs employed were paddle boats and had Watt's engines of about 500 h. p. with a pressure of 2 atmospheres; they towed 3 to 5 wooden Rhine Kähne or vessels with a total cargo of 10 000 to 12 000 Cwt. and used about 40 hours from Ruhrort to Köln with a consumption of about 2.5 kg. coals pr. hour and indicated h. p. or about 25 Cwts. pr. hour.

The first «Schleppkahn» or vessel to be towed which was built of iron and which had a length of 56 m,, 7 m. broad with a loading capacity of 4880 Cwts. while drawing 1.20 m. water was, as far as is known, placed on the Rhine by a Dutch company in 1841 and in the years 1846—1847 the «Kölnische Dampfschleppschiffahrts Gesellschaft» placed on service 3 steam tugs and 32 cargo vessels or Kähne. They also introduced the first propeller steamer. With the growing use of iron for the building of vessels the size of the Kähne gradually increased first to 400 tons capacity about 1850, to 1000 tons in 1880 and to 1500 tons, which is to-day considered as the most profitable type. Kähne of the last mentioned size are 80 m. long by 11 m. broad and go 0.46 m. empty, 2.40 m. deep when loaded. In the forecastle are the berths for 3 sailors, aft the cabin, the so-called «Roof» of the captain, and the round stearing gear. The open space for the cargo which can be covered with hatches is divided by 7 to 10 water tight walls. The cost of such a vessel amounts to Mk. 75 to 88 000 including all outfit. Some shipowning firms and private shipowners have built even larger vessels, upwards of 3600 tons dw.

On the Rhine are also to be seen Belgian and Dutch Canal vessels which have stables for the horses by means of which they are moved in the canals; they are all very clumsy owing to the desire to give them the greatest possible loading capacity.

From 1875 to 1880 modern tugs with compound engines superseded the Watt's engine and afterwards the tripple expansion engine was employed and the size of the tugs has also constantly been increased so that they may tow 4 to 5 iron Kähne with a combined cargo of 4000 to 4500 tons. The cost of a modern tug reaches Mk. 360 000. The speed when towing loaded barges up stream is 4.5 to 5 km. per hour. The latest improvement is the use of super-heated steam.

The passenger traffic has passed through similar evolutions. The newest types of saloon paddle steamers «Borussia», «Kaiserin Augusta Victoria», «Parcival» and «Rheingold» are palatially fitted vessels.

With the growing traffic the barges could not any longer be loaded and discharged at the natural banks of the river; artificial harbours had to be made, and during last century it has become necessary not only repeatedly to enlarge these, but also to fit them up with the most modern appliances for loading and discharging. The engineering firms, who have made a speciality of making cranes loading bridges and other loading appliances, have indeed contributed largely to the industrial development of the district by their ingenious improvements of discharging machinery. The basis of the industrial prosperity of the Rhine

Province and Westfalen is the possession of coals, but the iron and steel industry which has made such wonderful strides during the last 30 years is mainly dependent upon ore from other parts of Germany or foreign iron ore, and for this industry to become able to compete in the markets of the world it was an indispensible condition that the cost of transhipment of the ore at Rotterdam and other seaports and at Ruhrort or other Rhine harbours should be reduced to a minimum. And this condition has been fulfilled by the use of the discharging machinery of to-day.

There are a number of important harbours on the Rhine, but the largest of them and, in fact, the largest inland harbour in Europe are the Ruhrhäfen or the different harbours which are situated on both sides of the Rhine above and below the outlet of the river Ruhr, which flows from East to West through the largest coal mining district of Germany and falls into the Rhine by Ruhrort.

These Ruhr harbours comprise a number of harbours or loading places which are private property and the three public barbours: Duisburger Hafen, Ruhrort Hafen and the Ruhrort Railway Hafen.

In order to connect the coal mines in Westfalen with the Rhine the river Ruhr was made navigable by the building of locks between the years 1770 and 1781 and for the storage and transhipment of the coals at the mouth of the river storage ground was obtained by making dykes along the Rhine. At the same time a special fund, the «Ruhrshiffahrtsfund» was created for the maintainance and future enlargement of these communications. The revenue of this fund was derived from lock money, dues upon the coals which were transported and fines. The revenue of the fund was not to be used for any other State purpose, but should exclusively serve to improve the transport and shipping facilities for the coal mines, particularly by increasing the navigability of the river Ruhr and by providing space for transhipment at Ruhrort.

The fund has in a large measure met both these tasks. Without any grants from the State it has born the cost of the great regulation of the river Ruhr in the years 1856—1863, and the enlargements of the Ruhrort harbours since 1820. In 1868 the dues on Ruhr shipping were abolished and in the following decenniums shipping on the Ruhr completely ceased. The fund's revenue has therefore recently been derived exclusively from the Harbour Dues in Ruhrort.

During the period 1820—1890 harbour extensions at Ruhrort were mostly executed, when the fund had accumulated sufficient capital. But this financial method required comparatively long building periods, and it could not any longer be continued, when it was decided, in 1902, to construct an entirely new set of harbours at the side of the old ones, and also completely to modernise these. It was therefore considered necessary to make use of a large loan. The cost of the new harbours amounts to about 22 mill. Mk., exclusive of the new railway station in the harbour which has cost about 8 mill. Mk. and which the State Railways have had to bear. The loans are part of the State debt, but the Ruhr Schiffahrtsfund has to pay the State for interest 3½ % and 1 % for a sinking fund. The management of the Ruhrort harbour lies under the Regierungspräsident in Düsseldorf with a Baubeamter as a local manager.

Since 1905 the management of the harbours of the city of Duisburg which were originated in 1826—31 and which are situated close by the Ruhrort harbours has been amalgamated with that of the latter in accordance with an agreement between the State and the city of Duisburg.

The railway harbour was originally built by the Köln—Mindener Railway Co. in 1849/50 and came into the possession of the Prussian State on the nationalisation of the railways in 1886. It is now placed under the same management as the Duisburg-Ruhr harbours.

The *Ruhrorter Harbour* has 28. km. water sides, of which 2.81 km. vertical, massive stone quays, 9.4 km. «gepflasterte Böschungen auf einer steilen Spundwand.» The water area is 128 ha.

In the *Duisburg Harbour* the water sides are 11 km., of which 1.6 km. vertical solid stone quays. The water area is 41.5 ha.

The total area at Duisburg and Duisburg-Ruhrort including the Railway Basin at Ruhrort and the Hochfelder Harbour is 632 ha., of which 184 ha. water area, 225 ha. forwarding and storage land and 223 ha. are occupied by roads and railway lines &c. The railway lines are 265 km. in length.

For the coal traffic there are, besides a large number of loading galleries, 13 mechanically driven tippers, and 2 hydraulic and 7 electric tippers of the newest construction for unloading of railway trucks into vessels. The working of the tippers is almost exclusively done by the harbour management.

Private firms own and work 2 bridges with 70 m. reaching capacity for transhipment of ore, 18 corn elevators of 40 tons capacity per hour, 56 travelling steam cranes of 2 to 5 tons lifting capacity, 1 hydraulic 1.5 tons crane, 9 electric cranes of 2.5 to 5 tons, 5 electric full bridge cranes and 7 «Bockausleger» cranes of from 4 to 10 tons lifting capacity and upwards of 13.5 m. reaching capacity.

The harbours at Ruhr are the door of the lower Rhine—Westfalen industrial district.

The clearances amounted to

	arrival tons.	departure tons.	total tons.
1909	8 534 760	15 491 041	24 025 801
1908	7 646 225	14 422 424	22 068 649
1907	9 887 202	11 694 148	21 581 350
1900	—	—	13 450 000
1890	—	—	6 625 000
1880	—	—	3 000 000
1870	—	—	2 180 000

The *coal* traffic is the largest item and it is practically all for export; coals are only imported in exceptional cases in times of scarcity.

In 1860 about 860 000 tons reached Ruhrort and Duisburg by barges; by about 1880 the railways had absorbed practically the whole of this traffic. In the year 1907 10 614 817 tons of coals were shipped over the Ruhr harbours = 88.5 % of the whole export. Most of the coals are sent up-river; in the year 1907 6 786 281 tons went up-river and only 3 828 557 tons down-river; of the last mentioned quantity were sent

to Holland. . . .	3 045 622	tons
» Belgium. . . .	1 448 777	»
» France	203 465	»

Iron ore. The pig iron industry of the Lower Rhine and Westfalen is almost entirely dependent upon outside supplies of iron ore. The iron ore supplies of the Ruhr district itself have almost been exhausted and not more than 400 000 tons of ore are now annually produced locally while the consumption amounts to about 10 000 000 tons.

A part of the supply is obtained from other districts of Germany and is mostly carried by rail to the iron works. The foreign ores from Holland, Belgium, France, Spain, Norway, Sweden, Italy, Greece, Caucasia, Algeria and Canada are transported in barges from Rotterdam or Antwerp. The import of iron ore to the Ruhr harbours which in 1897 was 1 931 342 tons was 6 166 665 tons in 1907 of which 5 839 026 tons were foreign.

As most of the blast furnaces are connected with steel works there is not a great traffic at the ports in pig iron; but the traffic in raw steel, railway materials, building iron, bars, plates, wire &c. is the more important. In 1907 734 815 tons of iron produce was exported, of which 61 687 tons up-stream to middle and south Germany and 673 130 tons down stream, mainly or almost exclusively for export to all countries of the world and one half goes via Rotterdam and one half via Antwerp. The shipments of pig iron and iron produce totalled in 1907 1 031 046 tons.

The consumpton of cereals by the rapidly growing population of the Lower Rhine and Westfalen industrial districts can not any longer be satisfied by the inland production, and supplies have to be drawn from the Baltic, the Black Sea, the United States, Canada and from Argentina. There are in the Ruhrort harbours large corn silos and flour mills. Most of the corn comes via Rotterdam and only a smaller portion via Antwerp.

Among the Rhine harbours the Ruhr harbours take the second place for the corn importation with 826 102 tons in 1907; they are only exceeded in this respect by Mannheim which imported in the same year 1 014 262 tons.

Besides wood for building purposes this district uses a great deal of wood for industrial purposes, and as mining timber and as raw material for cellulose making. The wood is both of home and foreign origin and is received both in logs and as sawn. The home grown wood comes from the rich forest districts at the Upper Rhine (Schwarzwald) and from the Main and is transported on the Rhine. The arrival to the Ruhr harbours from these districts in 1907 was 228 304 tons.

Over the Rhine Sea ports, particularly Rotterdam and the other Dutch Rhine ports, wood arrives from Holland, the German and Russian Baltic provinces, Finland and Sweden, from America (pitch-pine) and in isolated cases even from Japan (oak). This importation reached in 1907 382 676 tons.

The goods traffic of these harbours is, of course, not restricted to the above mentioned staple articles; the copper, lead and zink works, the oil mills, chemical works &c and even sometimes the textile mills use the Rhine as the road for obtaining their raw materials, and for the building trade stone, cement, sand &c are received in large quantities. Of goods for immediate consumption petroleum is largely imported.

In an article on the depressed condition of the Rhine freightmarket of April 4th 1910 *Köllnische Zeitung* says:

Meetings have recently been held at Duisburg to consider the present lamentable condition of the Rhine shipping. While in 1900, when the Rhine traffic was 44½ mill. tons, the available tonnage was 2½ mill. tons, the traffic had increased at the end of 1908 to 65¾ mill. tons, while the tonnage of the fleet was 4 mill. tons. In 1909 the traffic reached 68 mill. tons, but the fleet increased relatively still more rapidly. The consequence is that the situation is extremely depressing. (The said newspaper had already in 1906 pointed out that an undue increase of the tonnage must bring about a catastrophe.) The deepening of the ship channel which has been going on, the many improvements in navigation in the mountain districts and on the upper Rhine have greatly facilitated the shipping; and the loading and discharging appliances at all the harbours along the Rhine and in the Sea ports have been improved to such an extent that to-day only a small part of the time is necessary which previously was used in harbour. The run of the tonnage is therefore so much more rapid and the efficiency of the available tonnage has been proportionately increased.

While it was a good investment until a few years ago to build Rhine vessels, the condition of the freight market has become so bad that shipping has resulted in a loss. All the leading Dutch shipbuilding yards are quite full of orders to far into 1911. In many cases these orders have been given by people who have not previously been connected with shipping, but who have combined to invest their savings in ships, because they had heard of the great profits obtained in previous years. The ship mortgage banks were welcomed, because they opened to poor skippers

the chance of becoming their own masters, but it cannot be denied that Dutch shipbuilders have used these institutions to obtain in depressed periods orders from buyers who had very little capital of their own and had to rely more or less upon credit.

The 7 Dutch ship-mortgage banks had in 1909 a share capital of 12 mill. gulden and had borrowed on their bonds 34 mill. gulden. At first loans were only granted up to 50 % of the value of the vessels, but the limit has gradually been increased up to 60—75 %. As there is a commission on these loans of 2 to 3 %, and the interest is 5 % with 2 % for sinking fund it is a heavy burden upon the shipowners and for the poor borrowers it is extremely difficult to meet these obligations when the sailings only result in a balance in the most fortunate instances, but more often in a direct loss.

In 1885/86 and 1901/02 the Rhinish freight market was also very much depressed, but at that time it was not possible in Germany to obtain mortgage loans on vessels and the owners were consequently as a rule men of substantial means who could afford to take the bad years with the good ones. In the year 1906 there was a boom in freights, but since 1908 the condition has been going from bad to worse, owing to the general depression of trade and because the water conditions have nearly the whole time been favourable.

The paper expressed the hope that the attempts which were being made to unite the owners of single vessels might be successful, and as there were signs of a general improvement in the iron trade it hoped to see also the Rhine freight market gradually improve. But if the shipping trade is again to become profitable, it is essential that both the private owners and the shipping Companies cease to increase the fleet so rapidly as in recent years.

THE INDUSTRIES OF THE LOWER RHINELAND DURING THE FRENCH DOMINION

For this sketch I have used, with the kind permission of the author, the interesting book: «Die Entstehung der Handelskammern und die Industrie der Niederrhein während der französischer Herrschaft» by Dr. Richard Zeyss, Syndikus of the Chamber of Commerce at Krefeld, Leipzig 1907.

The German lands on the left bank of the Rhine which the French Republic had conquered in 1797 were divided into four departments: the Roer department between Rhine and Maas, the Rhine and Mosel, the Saar and the Donnersberg departments. It is mainly with the condition of the first of these during the French dominion that Dr. Zeuss deals.

The Republic had abolished the Chambers of Commerce which had existed in France from 1700, as they were considered antagonistic to the principle of «Liberty and Equality». After Napoleon had become First Consul he re-established Chambers of Commerce in 22 French cities by a decree of 3 Nivôse of the year XI (Christmas Eve 1802) to which were afterwards added nine other places. Of these 31 cities the following were situated in the present Belgium: Brussels, Antwerp, Ghent, Brügge, Ostende; one in Switzerland: Geneva, one in the Italian city Turin, and the following in Germany: Køln, Mainz and Strasburg.

The chambers were composed of from 9 to 15 elected members, leading merchants, under the presidency of the Prefect or Burgomaster; they were purely consultative bodies who had to watch matters of interest for commerce and report thereon to the Minister in Paris. They also sent delegates to the *Conseil Général de Commerce* in Paris.

Napoleon wished not only to see commerce flourish, but also to support arts and above all the industries which were just at the commencement of the 19th century beginning to develop on modern lines.

The chemist Leblanc had invented the method, which is named after him, for converting salt into Soda, the production of Salz Saüre (muriatic acid) and improvements in the manufacture of sulphuric acid and nitric acid. This led to the starting of the first scientific, chemico-technical factories on a large scale. Similar improvements in the arts were the production of Salmiac (ammonia), the introduction of rapid bleaching by the use of Chlor and an improvement in the dyeing with Prussian blue, a substitute for Indigo. These inventions and improvements were of the greatest importance for the textile industries. Mechanical machines for spinning wool and cotton were also introduced, although they were still driven by hand and not by steam. And in 1801 the Lyons silk weaver Jacquard brought out the invention which bears his name, and which consists in making patterns in cloth by the use of cards fixed

on the loom, while previously this work had been done entirely by hand.

To develop the industries in France «*chambres consultatives de manufactures, fabriques, arts et métiers*» — industrial chambers — were created by a law of 22 Germinal of the year XI (April 12th 1803). This law contains the germs of a good deal of the present-day industrial legislation. In the following year such industrial chambers were created in 154 cities which then belonged to France, of which 10 now belong to Germany. In the Roer department the following 3 cities got such industrial chambers, between which the whole of the district was afterwards divided, viz:

Krefeld, 7 443 inhabitants, with cloth and cashmire, tobacco, silk and soap industries,

Aachen and Burtscheid, 23 412 inhabitants, with cloth and cashmire, sewing-needle, pins, tobacco, tanning and copper industries and

Stolberg, 1 925 inhabitants, with cloth and cashmire, brass and glass industries and blast iron furnaces.

The members of these chambers were elected by and from the leading manufacturers. By special order of the Emperor the Chambers were forbidden to print their reports, except on the permission of the Minister; they were solely instituted for the guidance of the Government and its officials. In a similar spirit Bismarck forbade, in 1881/82, the publication of the annual reports of the Prussian Chambers of Commerce, because they had criticized his protective policy and his plans for a tobacco monopoly. He, like Napoleon, wanted the co-operation of the merchants and industrials, but not independent action by their representatives, the Chambers.

The Roer department with a population of about half a million was the largest of the four new eastern provinces of the Republic and was composed mostly of previously Prussian, Kur-Kölnisch and Kur-Pfalzian lands; the two largest cities in the department, Köln and Aachen, had been free cities of the Realm. The department was one of the most important industrial districts of the then French Empire.

In the autumn of 1804, shortly after he had been proclaimed Emperor, Napoleon spent some weeks in the Rhinelands, visiting factories and inspecting canal works in the course of construction. He also instituted prizes for important industrial achievements or inventions, for the distribution of which the industrial chambers were to make suggestions.

In 1806 Napoleon held an Industrial Exhibition in Paris (opened in June) in connection with the festivities for his victorious army. The industrial chambers, including those of the Roer department, were ordered to assist in getting exhibits, and about 100 manufacturers from this department took part. The Exhibition was a great success, although the Emperor and his army were absent, war having again broken out. There were 1422 exhibitors in all and 231 gold, silver and bronce Medals were distributed, of which the Roer department got one gold and one silver Medal and several Mentions Honorables.

In connection with the distributions of the Emperor's prizes local industrial exhibitions were held in the Roer department in 1807, 1810 & 1813; at the distribution of 1813, which was the last one, the second prize was awarded for an exhibition of beet sugar and the third for a mechanically engraved copper plate for printing on linen and cotton cloth.

Napoleon used statistics extensively to obtain exact knowledge of the state of the industries. The statistics for the Roer department (Aachen, Köln, Crefeld and Cleve) for the year 1811 give the following results:

Works.	Workpeople.	Production value fr.	Export value fr.
2 494	58 043	68 540 000	18 806 000

In addition the 60 coal mines at Aachen employed about 7000 labourers producing goods to the value of 6.68 mill. frcs.

Among the textiles the French Government strongly supported the cotton industry, quite a new branch of industry for the Roer department; the production of beet sugar was also assisted by the Government both in opposition to England. The population of the Roer department in 1811 being estimated at 650 000 to 680 000, nearly every tenth person was thus employed in arts and industries. The wages are given in the statistics as varying between fr. 1.00 and 1.50, seldom reaching fr. 2. Of the largest manufacturers 7 employed from 258 to 3000 labourers each, the largest being the Krefeld silkmanufacturer von der Leyen who had a turnover of 3 mill. francs, his fortune being estimated at the same amount.

Similar statistics were planned for 1812, but wars and war preparations made it impossible to accomplish them.

The book of Dr. Zeuss contains a highly interesting chapter on the whole policy, belligerent and economic, of Napoleon. From free trade he was carried by degrees to the most rigorous protectionist tariff and ultimately to the total prohibition of the importation of all English goods. The object was to fight England with economic weapons, as it could not otherwise be reached. For the same purpose the French Empire was to be made industrially selfsupporting and the whole of Europe was to be conquered.

This policy, particularly the closing of the Continent, caused immense losses to the trade and industries of the Roer department, and we learn that the industrial chambers frequently tried to obtain concessions, but in vain. They at the same time offered strong opposition, when the German countries on the right bank of the Rhine, which had likewise come under French dominion, wished to become included in the French customs union. The manufacturers in the Roer department wished to retain for themselves exclusively the advantages of selling in the French markets.

The hardships of the enormously high prices, which were the result of the excessive customs duties

and the other drastic Government measures, finally alienated the sympathies of the population from the Emperor, although the chambers of industry had been commanded to send the Emperor loyal addresses in which his «wise» measures were lauded in the usual bombastic style. And no doubt the egotistical economic and industrial policy of Napoleon contributed materially to his downfall. But Dr. Zeuss' book gives evidence that in many respects his rule contributed largely to the industrial progress of the Roer department.

Napoleon did very much for the improvement of the means of communication in Western Germany. Thanks to her strong, centralized government France had already under l'ancien régime got a splendid system of high roads. Mainly for the better transporting of his armies, but also to facilitate trade Napoleon created a system of high roads, conceived on a grand scale, which ran into Switzerland, Italy, Holland and Germany; between 1800 and 1812 300 mill. Frcs. were used in the then French Empire for road making. A number of important roads were made in the Roer department, the earliest of which was the road from Aachen to Montjoie which Napoleon decreed in 1804 during his presence in Aachen, to the intense satisfaction of the inhabitants. In 1812 the road Venlo-Wesel was finished which was intended to be part of the transit route Paris—Hamburg. It would, said Napoleon in a letter to his Finance Minister of Aug. 17th 1811, shorten the journey between Paris and Hamburg by four days and thus bind those regions firmer to the Empire.

Napoleon was an enthusiastic builder of canals which he also intended, like the roads, for binding more closely together the different parts of his dominions.

He decided while he was still Consul, on July 28th 1803, that the Rhine, the Maas and the Schelde rivers should be united by means of a canal, navigable for large vessels, the costs to be covered by a tax on the spirit distilleries. Similar plans had been entertained by the Spaniards while they ruled in the Low Countries, and the work had actually been commenced, but was given up. The tracé which had been planned by the Spaniards was, however, not followed. The canal which was called «Grand Canal Du Nord» was finally settled by a law of May 6th, 1806; it was to run from Antwerp to Neuzz on the Rhine, opposite to Düsseldorf, a length of about 200 km.; the costs were estimated at fr. 12 845 920. The construction was commenced in 1808 and was intended to be finished in ten years, but the Emperor was impatient and work was greatly accelerated between 1808 and the summer of 1810.

In the meanwhile new and more ambitious projects were started for the continuation of the Schelde—Maas canal across the Rhine to the rivers Ems, Weser, Elbe and as far as to the Baltic and the Russian and Austrian rivers — in short, a Middle Europe canal communication. The idea was not exactly new, but it was revived when Napoleon's dominions had reached, after the overthrow of Prussia, to the Elbe. The French vassal States, the Great Duchy of Berg and the Kingdom of Westfalen, created by the treaty of Tilsit of 1807, commanded the middle courses of the river Ems, Weser and Elbe, and it was therefore natural to take a connection of these rivers under serious consideration.

The construction of the Nord Canal was discontinued in 1810, because the Emperor's attention had been in the meanwhile directed to a Baltic canal project, from the Baltic (at Lübeck) to Hamburg, and from the Elbe to the Weser. But although many projects were prepared and discussed these grand plans were never set in work — the Russian war and the downfall of Napoleon stopped their execution.

The completion of the Nord Canal was finally relinquished in January 1813.

The Napoleonic plans for canalising the North Western of Germany thus came to nothing; in our time they have been partially carried out.

In the year 1804 *Code Napoléon*, which had been declared the law of France on March 21st of that year, became the only civil law on the left bank of the Rhine. Previously, the most divergent legislations — in the Ruhr department alone, at least 7 or 8 systems in addition to Roman law — had been in force. Code Napoleon, a clearly defined modern legislation, was an immense advantage. It has remained law in these districts during nearly a hundred years until the recent enactment of a new universal German civil law.

Still more important for trade and industry was the enactment on January 1st 1808 of a universal commercial law, *code de commerce*. The *tribuneaux de commerce* which this law had called into existence shortly before the French dominion ceased, were retained in the Rhine Provinces under the name of Royal commercial courts and have been acknowledged by the commercial community, specially in Aachen, Köln and Krefeld, as having been very beneficial. On Oct. 1st 1879 they had to make place to the new Kammer für Handelssachen as instituted by die Gerichtsverfassung Gesetz — the Courts of Justice Law — of 1877. Yet another new institution was introduced by the French, viz. the *conseils de prud'hommes* out of which the modern industrial arbitration courts have been evolved. Such conseils were established at Köln, Krefeld and Aachen.

Chambers of commerce were established by Napoleon besides in the Lower Rhine also in a number of other German cities which came under his sway, for instance in Osnabrück, Bremen and Hamburg, but they were abolished when the French dominion ceased.

In the years 1820 to 1825 commercial corporations were formed with State authority in a few Prussian cities. Similarly a number of chambers of commerce were started in the years 1830 to 1848, likewise with State sanction.

In 1848 a Royal decree for the entire Prussian State was issued by which both the older and future Chambers of Commerce were regulated. They shall be established in all cities where trade and industry is sufficiently important to make it desirable, and they shall be approved by the King. 33 new chambers were opened in accordance with this decree from 1848 to 1870.

A law regulating the chambers emanated in 1870; this law was modified by a new law of 1897. At present there exist 83 Prussian Chambers of Commerce.

A chamber may be established, when the traders of a place wish it, subject to the approval of the Minister for Trade and Industry who fixes the number of its members and its district. The object of the chambers is to guard the interests of trade and industry, and to assist the servants of the Crown by giving advice in commercial matters. They are also empowered to start or support institutions which may further trade and industries, such as technical colleges. Exchanges and similar institutions may be placed under their supervision. They have a seal, containing the heraldic eagle of Prussia.

The members are elected by and from the commercial and industrial firms of the city.

THE INFLUENCE OF LEGISLATION ON GERMAN BUSINESS

From the Trade Review of 1909 of the Düsseldorf Handelskammer (Chamber of Commerce), published Janr. 1910, I have taken the following extract:

During nearly three quarters of the year the proposals for a Finance Reform of the Empire have pressed heavily on our business community and prevented an expansion of trade. This influence is daily felt. Many branches of industry and commerce have not yet recovered from the blows which they received from the majority of the Reichstag and they will most likely have to suffer therefrom for a long while yet. The reform of the finances of the Empire has not even been quite sufficient to meet the requirements; but it has, at any rate, had the result of opening the eyes of artisans, commercial and industrial men as well as public carriers to the dangers which threaten them, and to unite them in an Association for guarding their own interests. The *Hansabund für Gewerbe, Handel und Industrie* is probably the best, albeit unintentional, consequence of the Finance Reform.

This reform will also, it may be hoped, have this further sequel, that industry, commerce and the carrying trade as well as their representative bodies will revise and change in the future their policy with regard to taxes. There is, so far as we have observed, not one single representation of these trades which approached the Finance Reform in such a spirit of pure class interests as the Farmers' Alliance. They have all primarily looked at the matter from the point of view of the good of society at large and have assented, although with the greatest misgivings, to taxing proposals which have met with the strongest opposition among their own members. But the progress of the Finance Reform has shown that such uninterested policy is not the right one under existing conditions. The political parties which pretend to represent the interests of commerce and trade ought on the other hand to understand that one does not generally obtain so very much by demanding everything.

In our report of last year we have drawn attention comprehensively to the burdens which have been put on the shoulders of commerce and industry and which are still threatened, and how small are the concessions which the trades have received from the Government and Reichstag, even when their demands have been very modest. If we review the economic legislation of the current year, we shall find that the case is, unfortunately, unchanged.

Apart from the Finance Reform there was not much legislation last year with regard to economic matters. Fortunately, for had there been more of it, it would probably not have been pleasing to the business men of the country. The Wine Act has brought the wine trade excessive difficulties, burdens and losses; the same may be said of the Act relating to the taxing regulations for barley, which was, as is generally acknowledged, quite uncalled for. As regards the Act for regulating the motor car traffic and the Act for securing creditors in building estates, there is great cause for anxiety. Opinions differ, it is true, about the Building Estates Act, but those who fear that it will hamper the building trade are in the majority. The banks and other capitalists will probably not be free lenders of money for building purposes where the act is fully enforced, and certainly not except on harder terms, to compensate for the increased risks. The regulations for boilers, for the employment in stone quarries, Thomas flour mills, preserving factories

and zink works all narro wthe freedom of action in these trade considerably, and more than necessary. In the Coinage Act the silver people have received concessions. The railway traffic regulations do not quite meet the desires of the public. The only Act of the Empire which was satisfactory to commerce and industry was the Bank Act.

Prussia has thrown a good deal of the enlarged revenue of which she was in need on the shoulders of the Limited Companies. The laws which are imminent, principally the insurance law of the Empire, the change in the Gewerbe or industrial Act, the Chamber of Labour law give cause for the greatest fears. It is characteristic of the prevailing tendency against industry and commerce that the revision of the telephone charges for distance traffic is proceeded with quite unchanged, although the proposed tariffs will add considerably to the expenses of traders. And we again repeat the question which has been raised for years: What is to become of the reduction of the railway tariffs?

The Government and Reichstag ought at last to recognize how heavily commercial and industrial undertakings are burdened. They would be astonished at the burdens that have already been established and would certainly not dare to add to them. We have ascertained as regards the district of our Chamber of Commerce what burdens actually fall on our limited companies. Not all the companies whom we have asked for information have considered it worth their while to reply. Some have supplied incomplete statistics.

The burdens are extremely heavy and increase at an alarmingly rapid rate. Already during 1909 quite a number of new or increased burdens have been added, and the reports for last year and the current year which have not yet been published will therefore show that a still larger part of the profits of the economic undertakings must be surrendered to society.

One company for instance informs us, that the rates and taxes which amounted in 1908 to Mk. 89 020 reached in 1909 Mk. 107 810, a rise of 21% in spite of a smaller surplus on the year's trading. This gives some idea of how great the increase of the burdens is. It is a little too rough when the companies are treated in one year to a 50 % increase of the State income tax, and further with increased share-bond- and Bill of Exchange stamp duties, with talon- and Check stamp duty, with a tax on electric lamps, on electric mantels and on electro-carbons, to say nothing of the taxes which do not fall upon them specifically and directly, but which also hit them like other citizens.

About 19% of the amount which the shareholders received as dividends in the iron trade limited companies went to social purposes in addition to taxes of 6.9 and in last year 13.4 %; consequently a third of the amount, which might be paid to the shareholders had to be set aside for meeting the demands of the State and for social purposes. The burdens on the transport companies were about the same; less heavy, but quite heavy enough were the burdens in other branches of industry, and lighter for the commercial companies. These figures therefore fully compare with those which were recently published in regard to the taxes and other burdens of some very prominent undertakings. For the Bockumer Verein the taxes and other burdens where in the last year equal to 49.7 % of the dividends, for the Harpen Co. as much as 73.8 % of the total profit; Krupp A.G. has spent for these purposes 93 % of the dividend and the Gutehoffnungshütte 80 %, and if the Jubilee donations are added, quite 100 %.

So big are the sums which must be taken from the gross profit for taxes and social purposes, that they represent the above stated percentages on the dividends. If it does not actually kill our industry, it must tend to weaken its ability to meet foreign competition. The danger of such heavy burdens lies in their ultimate consequences.

But the burdens act in individual cases sometimes much worse than our table indicates; for as there are companies who make either a very small or no profit or even losses the taxes and social expenditure become for them very serious indeed.

And it must also be born in mind that the same profit which is taxed so heavily with the companies, is taxed over again with the shareholders, which acts the more heavily in proportion as the local taxes are high. This double taxation which is an outrage on equity is also an example of how carelessly the Government and Reichstag treat the taxation on industry. Double taxation by co-ordinate authorities, for instance several of the United States, is felt to be such an injustice that it is to be prevented by a new law. But one has no compunction in submitting the capital which is employed in industry, commerce and transport to this iniquity. If anything similar were tried against agriculture a storm would break loose which no cabinet minister would be able to stand.

The contributions from industry and trade to the State Exchequer are not at all exhausted by the direct taxes. Consider only what enormous sums the productive classes contribute to the coffers of the State by the railway freights. The surpluses which the railways have to pay annually to the State have in some years very nearly reached the same sum as the direct taxes. For the year 1910/11 Prussia's income from the railways is estimated at 151 mill. Mk., more than one fifth of the entire income of 715,1 mill. Mk. It is of course industry and commerce which must provide by a long way the greater part of this sum. That the Imperial Government and the Reichstag thought that they might introduce a stamp duty on the Bill of Lading and a tax on the consignment letter in addition to this large indirect taxation is evidence that the legislative authorities are still in the dark as to how much has already been placed upon the shoulders of industry, commerce and transport.

Our figures show which large amounts the industry still spends for voluntary benevolence in spite of the excessive legal burdens. These sums are in the main used as contribution to the sick funds of

workpeople and officials, support of sick employees and widows, contributions to hospitals, churches, benevolent associations for building houses for employees, contributions to building societies and the like. It is mostly permanent contributions, and the voluntary benevolent contributions are not fully shown in our table, for they do not contain the large previous donations, the interest of which are annually spent for benevolent objects.

It may he doubted if the industry will also in the future be willing to bear so heavy voluntary burdens or to increase them, when there is so little appreciation of what has already been done. We do not here think of the labourers who frequently do not value what they do not see in hard cash; but we have in view public bodies and above all the Reichstag. Certain parties in the Reichstag seem to have lost the sense as to how the industry may be treated.

It is greatly to be regretted when men of science, as for instance Professor Dr. C. J. *Fuchs* in Tübingen a few years ago, can say: «There is no doubt that the sense of social obligations is much less common among us than in the rich and educated classes in England and the United States, and that we are too individualistic to act so altruistically» — — such utterances must, when compared with our figures, be described as lamentable aberrations.

Considering our proofs we cannot be charged with exaggeration when we express the opinion that these conditions must hinder the formation of capital, and that they do harm to the progress of trade, industry and transport which create wealth. And this plain statement ought finally to carry weight with the Reichstag, although it seems to decide without troubling much about the financial consequences.

DÜSSELDORF

Düsseldorf, the Dorf or Village by the Düssel, was made a fortified city by Count Adolf V von Berg in 1288, because he wished to have a stronghold on the Rhine against the Archbishops of Köln, who did all in their power to prevent any of their neighbours among the territorial magnates from becoming too strong.

During the first 100 years the little city did not, however, prosper as its founder had hoped, and the main reason was that the Rhine duties crippled shipping and trade on the river. Charles the Great had established customs houses on the Rhine and used the revenues for the assistance and protection of trade; but as the authority of the Emperors was gradually weakened, the territorial magnates established a great number of customs houses solely for their own enrichment; at the end of the 14th century there were not less than 62 of these barriers to the free intercourse on the river, and at last traders avoided the Rhine as far as possible.

But from the 15th century Düsseldorf commenced to grow in spite of all drawbacks. One of these was the «Stapelrecht» which Köln possessed, a privilege which gave that city the right to demand that all goods which passed by should be landed for a certain time and offered for sale, before being sent further. Besides Köln, Mainz, Speier and Strasburg had this staple right which of course was a serious hindrance to free trade and intercourse along the Rhine, which particularly prevented Düsseldorf from developing as it otherwise might have done. The city suffered also terribly from the Julich-Cleve succession-war and the 30 years' war, but one important thing was created in the 17th century, viz. the first Düsseldorf harbour, opened in 1620, which was in use till 1811 when a better harbour was constructed, which has in turn given place to the large and fine modern harbour.

Under Kurfürst Johan Wilhelm Düsseldorf became in 1684 the residence of a luxurious court; he tried to foster commerce and industry, but towards the end of the 17th century the duty evil was worse than ever, for the duty was the milk cow from which the many petty Sovereigns obtained the means by which to keep their courts in French style.

When the town was taken by the French in 1795 it had commenced to prosper. The Handlungs-Vorstand, a sort of Chamber of Commerce which was started in 1798, commenced sending ships in regular route between Düsseldorf and Holland and opened a bonded warehouse at the harbour. Napoleon's rule was, however, not advantageous to Düsseldorf in particular, and the city suffered like the rest of the Rhineland under his wars and the consequences of his economic policy.

Neither did the Prussian rule at first benefit the city; the old taxes remained and new ones were added, and in 1817 a commercial crisis broke out, because the English goods which the closing of the Continent had kept back, suddenly flooded the markets and had to be sold at any price. The

German manufacturers who had had the inland market all to themselves, thus met a new and ruinous competition and a number of firms failed as a consequence. And the Prussian Government maintained the staple rights of Köln; no vessel from above or below might pass Köln without unloading; the business of Düsseldorf dwindled; commerce was lamed not only by the Köln staple, but by heavy import duties and inland accises. An improvement did not begin before the Rhine shipping convention in 1831 at last made the traffic on the river quite free.

Meanwhile Düsseldorf had already become the seat of a famous Academy of Arts, but it remained a town of a moderate population until the Franco-German war. Since that time the evolution of the iron and steel industry has caused the city of Düsseldorf, which has become the centre of this trade and the seat of the Stahlverband, to grow by leaps and bounds. It has reached, after the suburbs were incorporated on Janr. 1st of 1910, a population of about 350 000 and around the Altstadt large, finely built new quarters have grown up in every direction. The «garden city» the inhabitants like to call it, and with good reason, for large beautiful gardens and broad tree planted avenues intersect the town in all directions.

Düsseldorf that is situated on the right bank of the river is a very important railway centre; it is about equidistant between Köln in the south, Duisburg and Ruhrort in the north; at its back lie the twin cities Elberfeldt and Barmen, famous for their textile and colour manufactories, Solingen and Remscheid with their large cutlery trade, while behind the low crest of hills is the Ruhr valley with Duisburg, Dortmund, Bochum, Essen, Gelsenkirchen, Oberhausen, Mülheim a. d. Ruhr besides many smaller towns where coal mines and iron works abound. On the other, the left side, of the Rhine, are Krefeld, the silk city, M.-Gladbach with her textiles, Aachen, an important coal mining centre with large cloth manufactures, and innumerable other large or small towns. And on both banks the land is dotted with villages.

The Rhine, the railways and the iron trade have transformed in the course of a generation Düsseldorf from a quiet residential and art town into an intensively active industrial and commercial modern city, where money is rapidly made and also quickly spent, but where the people work as energetically as in the United States.

THE INDUSTRIES IN THE KÖLN DISTRICT

Modern industrial development in Köln dates from 1830—1850 when steamships and railway lines, centring in Köln, created new economic conditions. Of old pre-railway undertakings the «Kölner water» which bears the name of Joh. Maria Farina is about the only one of importance which still survives.

The iron industry is largely represented and very varied; besides engineering works there are several railway car builders. The Deutzer Gasmotorenfabrik is a very important firm; Felten & Guilleaume in Mülheim a/Rhein who have a capital of 30 Mill. Mk., Land- und Seekabelwerke with a capital of 6 Mill. Mk. and Norddeutsche Seekabelwerke produce cables for telegraphs and telephones for which industry the district of Köln has therefore become one of the most important centres. The Land- und Seekabelwerke is an offshoot of the Rheinische Gummiwarenfabrik Franz Clouth in Köln-Nippes which has likweise grown very rapidly.

Owing to the presence of lead ores in the neighbourhood the white-lead industry is an old one.

The chemical branches are represented by a number of firms, such as Chemische Fabrik Kalk, vorm. Vorster & Grüneberg; Weiler, Scheibler & Co.; Vereinigte Ultramarinfabriken, vorm. Leverkus; Zeltner & Co.; and Farbenfabriken vorm. Friedr. Bayer & Co. who have transferred a large part of their works to Leverkusen near Mülheim by Rhein. There are several gunpowder firms, and other chemical branches are also represented.

We find further varnish makers, soap works and important glas works; the Rheinische Glashüttenaktiengesellschaft in Ehrenfeldt produces fine art work.

Sugar works produce beet sugar from beet grown in the fertile Rhine valley, and the chocolate industry is represented by such names as Gebrüder Stollwerck and Hewel & Veithen. Some of the tobacco manufactories date back to the beginning of last century.

In Mülheim we find the old established firm of Christoph Andreae, a large velvet and plusch mill.

In the district there are several large paper mills.

The famous art industries of Köln, especially in iron work and jewellery, have in recent times reached a development which nobody would have thought possible, thanks to the educational facilities and to the growing demand from the wealthy population.

The stone industry, and particularly the produc-

tion of fire proof bricks, is a very important one, and the Rhinish basalt industry has its centre in Köln.

The use of brown coals from the large deposits near Bonn has greatly increased since one has learnt to press them to brickets. A number of companies carry on mines in the immense brown coal measures and the number of industrial firms who use these coals for fuel is therefore on the increase. Recently these coals are also used for producing electricity at the mines, to be distributed by transmission. The City of Köln has also secured a coal field for the purpose of obtaining power by transmission. It is expected that the electric power thus obtained will lead to a large industry springing up above Köln on both sides of the river.

The shipping on the Rhine which had been to a certain extent neglected after the railways had been built, has quite recently increased again, and warehouses have been provided in the extensive new harbour. Not only Rhine vessels, but also some Rhine—Sea steamers are run from Köln.

KREFELD,
THE CENTER OF THE GERMAN SILK INDUSTRY

Krefeld was in the 15th and 16th century a small, out-of-the-way village in the unimportant Grafschaft of Mørs. Linen weaving was carried on, but this industry did not obtain any importance, before Reformierte (Protestants), and Mennonites, expelled from the neighbouring States, settled in Krefeld in the 17th century. Several of their descendants are prominent people there to-day.

The first to introduce the silk industry were several members of the immigrant family *von der Leyen;* Adolf von der *Leyen,* who became a citizen in 1679, is considered as the founder of an industry which has afterwards made the name of Krefeld famous. Shortly after he had started his factory the population of the place had increased to 4 000.

The family von der Leyen enjoyed to a great extent the favour and protection of the Prussian rulers, particularly that of Friedrich the Great, who made it impossible for anybody to start competing factories. As a consequence the firm von der Leyen prospered and possessed about 1760 15 silk yarn mills with about 300 labourers and 200 ribbon mills with 1000 labourers and further some 500 weaving looms for velvet, silk cloth, kerchiefs, ribbons und oriental pieces by which at least 1500 people were supported.

At the end of the 18th century the trade of the town had increased to a considerable extent and the population had grown to 10 913 in 1808 in spite of the fact that the French Revolution greatly disturbed the business. At this time the von Leyens' lost their monopoly and new silk firms were established.

The warlike times prevented, however, the trade of Krefeld from flourishing, the more so as the French, who had taken the town in 1794, did a great deal of harm to its trade by imposing customs duties on raw silk without giving a drawback on the exported fabrics. On the other hand they tried to stimulate business by establishing in 1804 a chamber of manufactures (chambre consultative des manufactures, fabriques, arts et métiers) at Krefeld and in 1809 a court of justice for commerce was established.

From 1814, when Krefeld became Prussian, trade again began to flourish. In 1825 there were 25 commercial firms, in 1832 13 «Seidenmanufactur Verleger» or houses who employed the cottage silk industries, and in 1835 there were 28 silk manufacturers who had 1600 Jacquard looms for silk and half silk goods, 1280 for velvet, 740 for Plusch, 630 looms for Plusch ribbons and 280 ribbon «mills». In 1848 the number of makers had grown to 98 who employed 14 300 labourers on 10 000 looms, while there were in 1864 270 makers with 30 000 looms.

At the beginning of the 60'ties the first experiments with power silk looms were made, while the power loom had long before that time been fully introduced in the Cotton trade. The power silk loom was, however, still far from perfect. It was the war of 1870—1871 which carried with it great improvements and progress in this as in so many other trades. Shortly after its termination the first power looms were actually set working in Krefeld, and once introduced they rapidly won the entire field. At first the power loom was used only for plain silks, afterwards for shaft patterns and very soon it was applied to the Jacquard loom also. To-day patterns are produced on the power loom which reach a beauty and variety in effect which the most optimistic would not previously have dared to hope for. It had taken a day

for a diligent handweaver to produce one meter of velvet, while on the power loom 60 meters may be produced in a day; it is evident that the introduction of the power loom created a revolution in the industry. The home industry which used to be carried on so extensively in Krefeld itself and in its neighbourhood, has given place more and more to factory work. The 17 800 hand looms of 1882 had shrunk to 2850 in 1899; in 1882 there were only 299 power looms, but their number had increased to 2214 in 1898.

The silk trade of Krefeld is mainly confined to such textiles which are used for clothing purposes by ladies and gentlemen and almost exclusively to current, staple articles. The production consists of whole or half silks, plain or in patterns, for ladies dresses, velvets, plain or in patterns, also for ladies dresses, collar velvets, which are still produced on hand looms, silk linings and umbrella silks. Whole or half silks for neckties is a large article as well as piece-dyed satins for linings; further ribbons in silk or velvet.

In 1899 the turn-over was reported to be Mk. 82 167 759 of which goods to the value of 43¾ mill. Mk. were sold in Germany and the rest exported. Mk. 21 610 000 were paid as wages to weavers and for subsidiary work including dyeing and finishing in the same year.

Recently the manufacture of carpets has also been introduced into Krefeld.

The textile manufacturers of this town are always on the look-out for technical improvements and the merchants are constantly trying to find additional customers in every country of the world for the output of the looms.

Krefeld lies on a perfectly level plain and as it is laid out on the American system with streets that cross at right angles, one may see from one end of the town to the other. The houses are mostly only two-storeyed; considering that it is a manufacturing town exclusively, it is remarkably fine and cheerful.

At my visit I was introduced to the director of the Preussische Höhere Fachschule für Textil-Industrie (Spinn- und Webeschule) Herr Professor M. *Lehmann* who explained that the object of the school is to give a technical education in a course of 1½ years' duration to young people who intend to become manufacturers, directors or merchants in the textile branches. I was permitted to go over the school which is fitted with complete machinery for the treatment of silk, and a fine museum of textiles. The school which is considered one of the best of its kind attracts students from other silk producing countries, notably from Lyons.

At the Krefeld Chamber of Commerce which has its headquarters in an exquisitely beautiful modern Gothic building, I was most cordially received by the Syndic, Herr Dr. Richard Zeuss, who most readily consented to my request to be allowed to make an extract from his very interesting book about the Lower Rhine during the time of the French dominion; he also kindly obtained for me permission to visit the factories of F. W. Deussen and Krahnen & Gobbers Ltd. He also gave me a copy of the statistics of the silk trade for last year, compiled by the Chamber of Commerce, of which the following is an extract.

average number:	1906.	1907.	1908.	1909.
of looms at work, hand looms ..	3 599	3 221	2 657	2 696
power looms ..	10 141	10 002	9 566	9 949
	13 740	13 223	12 223	12 645
value of sales:				
velvet .. .. Mk.	26 192 102	30 584 643	23 103 839	24 081 004
silkstuffs	56 717 733	59 572 939	53 858 129	58 058 629
	82 909 835	90 157 582	76 961 968	82 139 633
wages	22 119 954	21 878 361	19 034 829	20 879 785

The sales were distributed thus:

	1905. %	1906. %	1907. %	1908. %	1909. %
To Germany	60	61.59	60.20	61.35	61.63
Austria Hungary	2.71	2.93	3.09	3.64	3.77
England	16.92	15.56	15.43	15.21	14.82
France	5.70	5.40	6.64	4.90	5.27
other European Countries	6.47	6.49	7.31	8.31	7.92
outside of Europe	8.20	8.03	7.23	6.59	6.59
	100.00	100.00	100.00	100.00	100.00

The population is now 125 000 of which about 80 000 are reckoned to be labourers.

SPECIAL TRAIN LOADED WITH HANIEL & LUEG'S CAST IRON SHAFT-LINING RINGS.

MESSRS HANIEL & LUEG,

ENGINEERING WORKS, IRON & STEEL WORKS,

DÜSSELDORF

This firm was established in 1873, being still carried on as a private business, while most other large industrial concerns in this district have been converted into Limited Liability Companies.

The works which cover a large piece of land were much enlarged in the year 1899; on this occasion the big buildings for the steel works and the engineering works were built in modern style. They are very high with plenty of light from the roof.

Herr Bruno Moersen, chief of the steel works department, who had been deputed to show me the works, made the tour of inspection a source of the greatest pleasure and instruction for me, and as he showed me only such items which were characteristic of the firm, we were able to finish in less than two hours and without fatigue, after a walk through all the departments.

As we started, Herr Moersen drew my attention to a number of enormous Shaft Lining Iron Rings for mine shafts which had been cast in one piece; they had a diameter of 4.1 to 4.4 m. and weighed 10 000 to 20 000 kg. Shaft rings are also made in segments. The production of such cast iron rings as well as of shaft boring machinery is one of the oldest branches of the firm. To the beginning of 1910 they have delivered such rings totalling a weight of 250 000 tons.

Having examined these rings I was fully prepared to see an exceptional foundry. The capacity of the cupolas is 9 to 10 000 kgs. in the Main Foundry and 5 to 5000 kgs. in the Tube Works. The foundry is fitted with so powerful cranes and so large and deep moulding pits that they can, as my guide said, undertake to cast pieces of any size that may be required.

In the Tube Works an interesting patented method is used for forming the moulds, and the casting process is a marvel of rapidity and exactitude. All tubes are tested before being sent away.

The Forge is equipped with 3 large and 5 smaller steam hammers; we inspected, however, only the hydraulic plant for making large forgings from ingots, weighing from 10 to 65 tons, by means of two steam hydraulic forging presses which exercise a pressure of 3000 and 2000 tons respectively. These presses were designed after the firm's own system and executed at their works. Besides, the firm have made a speciality of the construction of Steam-Hydraulic Presses on their own principle, which are built as forging presses for making large forgings, armour plates, etc., as bending and beading presses, die presses, etc.

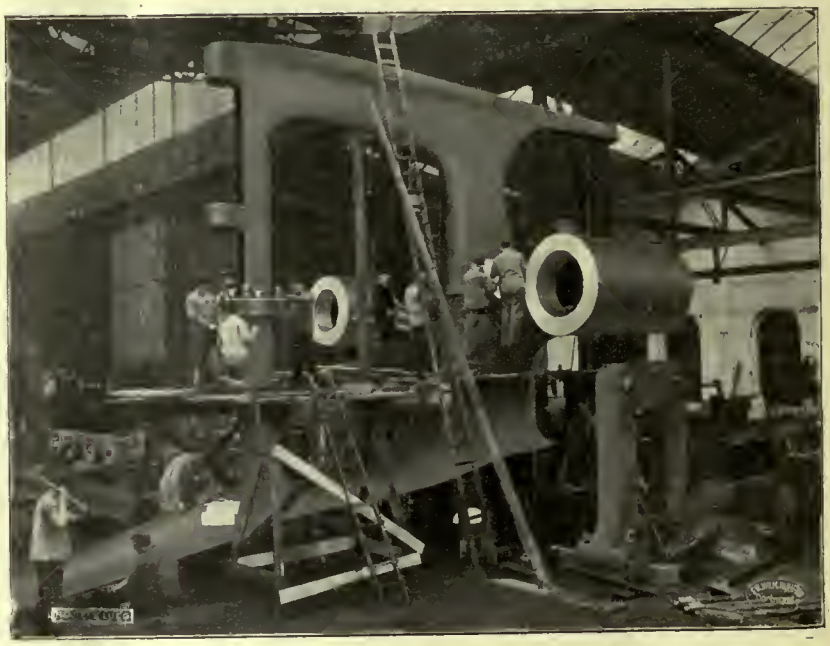
At the time of my visit an ingot, weighing 55 000 kg. and intended for a column, was being forged; it was quite marvelous to observe how easily and rapidly the huge machinery was regulated by simply turning the handles. Close by the press were the furnaces in which these big pieces are heated before being placed under the forging press.

The Steel Works cover an area of about 9000 m^2 (80 000 square feet). It has three Siemens-Martin Open Hearth Furnaces, one capable of delivering a 30 ton, the other a 40 ton and the third a 60 ton charge. The lifting arrangements are capable af dealing with 300 tons in all; they comprise an overhead travelling crane of 80 tons and 10 tons and two others of 50 tons capacity each. The casting pits,

SHAFT OF 82 TONS WEIGHT FOR THE WALLSEND SLIPWAY AND ENGINEERING CO. LTD., WALLSEND-ON-TYNE.

drying stoves, annealing furnaces etc. are all on a big scale, and ingots are cast from Siemens-Martin homo genous iron, Siemens-Martin steel and Nickel steel, suitable for forgings up to a weight of 70 000 kgs. (70 tons). The firm uses the Riemer process; when an ingot has been cast, a gas heat-generator is placed on the top of the cockille during the cooling. This keeps the metal at the top fluid and the open space in the middle of the ingot which is formed under casting with the ordinary process by the contraction of the cooling metal, is thereby avoided. This process, which is quite sufficient rof ordinary commercial purposes, is inexpensive. Herr Moersen showed me two ingots which had been cut in halves and of which photos are reproduced on page 29. Block I had been cast with the ordinary method, block II wit h the Riemer process.

Besides supplying their own requirements the firm produces octagon and flat steel ingots and slabs for sale; I was shown a large stock of ingots in the yard, as also the scrap iron heap of fine affal from the various engineering shops. It is no use to attempt to make good steel, remarked Herr Moersen, unless you have good raw materials. By the use of mechanical appliances the charging of the Siemens-Martin furnace has heen made as easy as child's play. We inspected the many big cast pieces and the moulding pits. Every piece of work is annealed, before being sent away, in annealing furnaces which were explained to me. I was told that the process was a very expensive one, but it was resorted to in order to be able to guarantee perfectly reliable goods.



REPLACE STERN FRAME FOR NORDDEUTSCHER LLOYD LINER «KAISER WILHELM DER GROSSE» WEIGHT OVER 84 TONS, CAST AND FINISHED IN 48 DAYS.

COGGING MILL ROLLS FOR COMPAGNIE DES FORGES ET ACIERIES DE LA MARINE ET D'HOMECOURT, HOMECOURT.

The Engineering Works I and II are equipped with the largest and most powerful machine tools and cranes and can handle pieces weighing upwards of 60 tons. I was particularly struck because of their immense size by the horizontal lathes, or mills, of which there were not less than 8 in operation. It was also interesting to observe the large machine planing floor where the work is fixed on the floor and operated upon with portable tools; as many as 6 machines may be employed on one piece at a time.

In the Erecting Shop I saw gas-engines in course of erection. Although the firm does not, generally speaking,

produce articles wholesale, being mostly confined to making quality goods, the production of large gas engines for iron masters to utilize the furnace gases has become almost a wholesale production, so many of these engines are turned out by the firm.

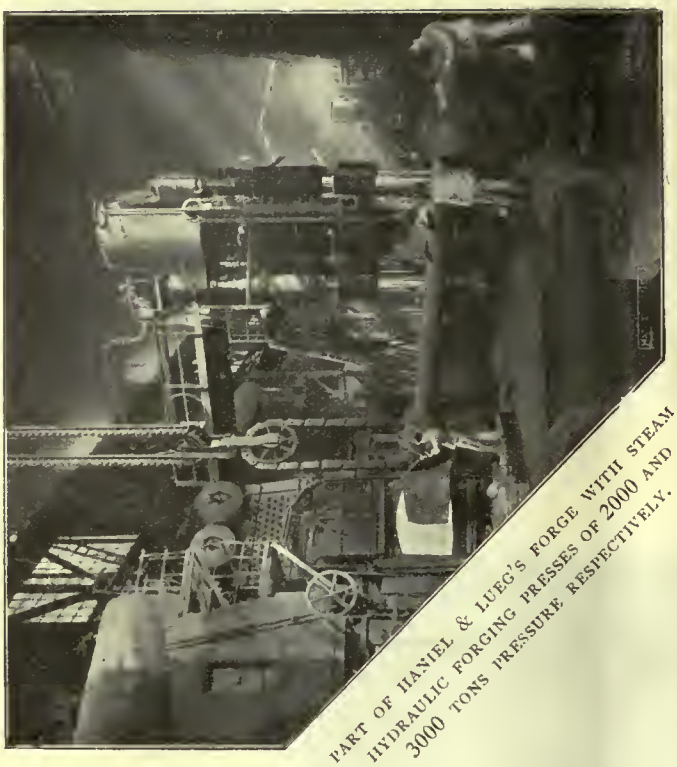
From this short description and even more from the illustrations the reader will understand that this firm, which stands in the very front rank among German machinery makers, devotes its energy mostly to the production of very heavy machinery.

Of their specialities may be mentioned·

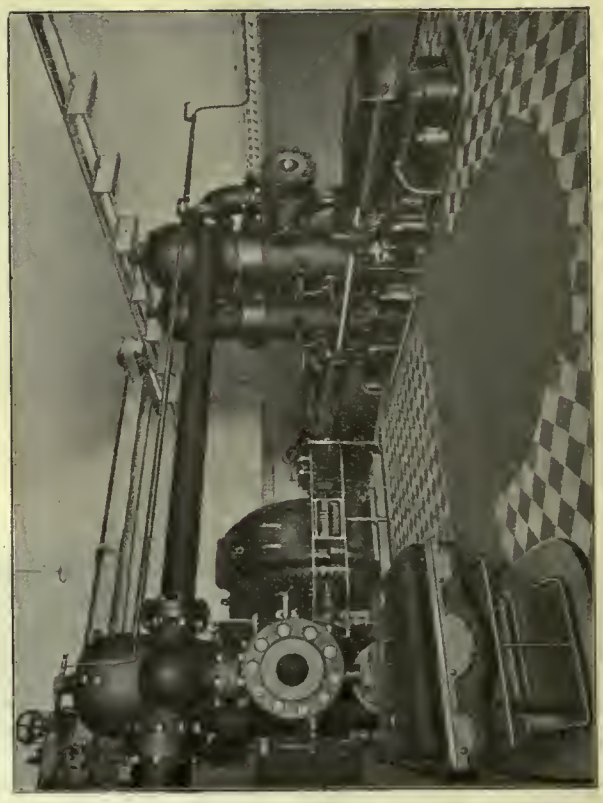
Hydraulic Machinery of all kinds, viz.:
Hydraulic Presses of every description,
Hydraulic Rivetting machines,
Plate Bending machines, etc.
Mining Machinery,
Pumping Engines for mines and various other purposes,
Complete Rolling Mill Plants, Hoisting frames,
Large Power Gas Engines,
heavy iron castings,
steel ingots and steel castings,
forgings for shipbuilding and machines,
cast pipes.

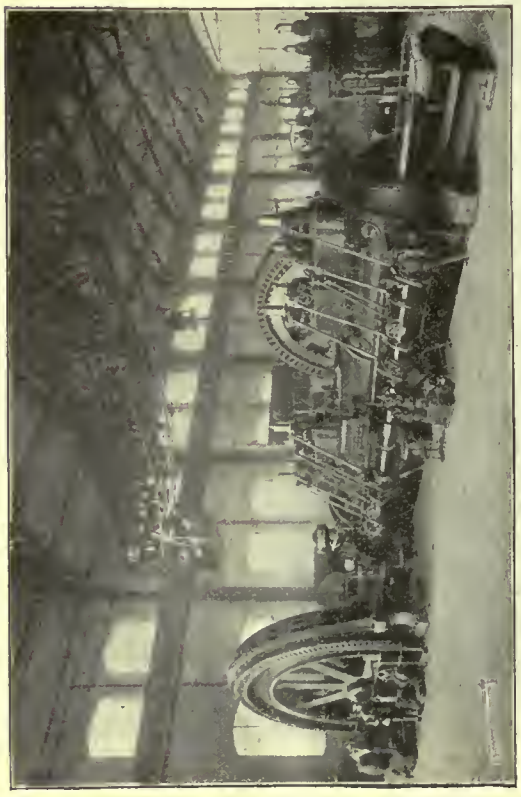
Commodious lavatories and eating rooms have been arranged in every department, and in a number of places in different parts of the yards small gardens have been planted where the labourers may in fine weather drink their coffee and smoke their pipe during rest time.

59 TONS STEEL INGOT SUSPENDED FROM A CRANE, AS TAKEN FROM THE CASTING PIT.

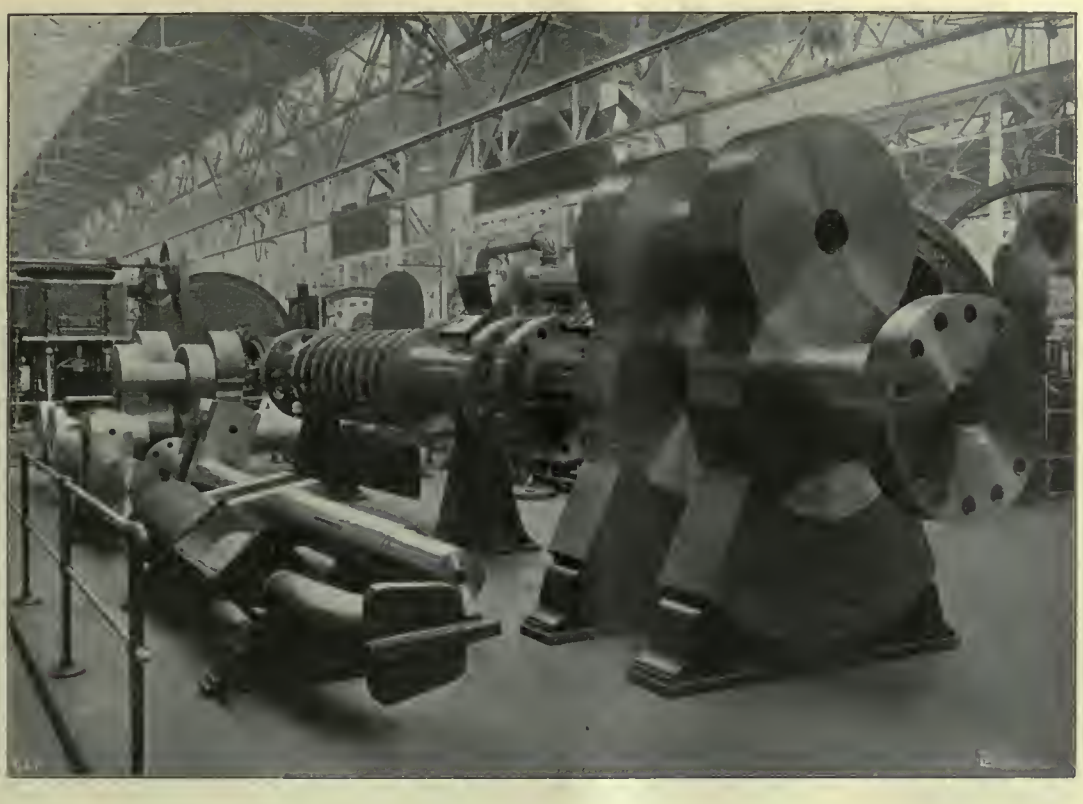


PART OF HANIEL & LUEG'S FORGE WITH STEAM HYDRAULIC FORGING PRESSES OF 2000 AND 3000 TONS PRESSURE RESPECTIVELY.

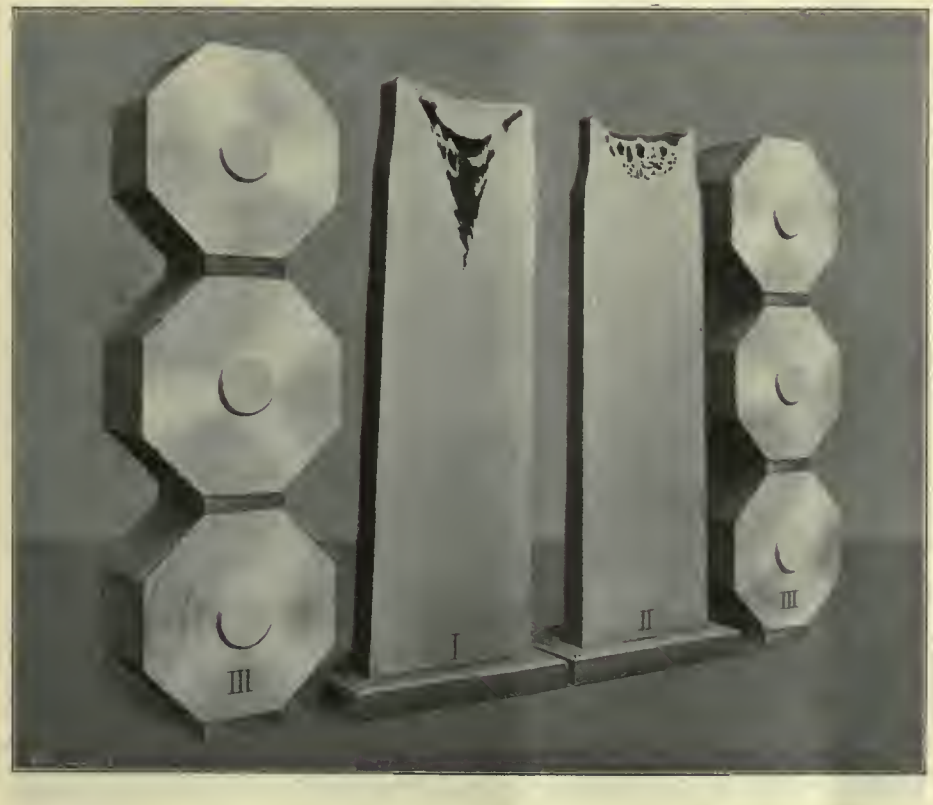




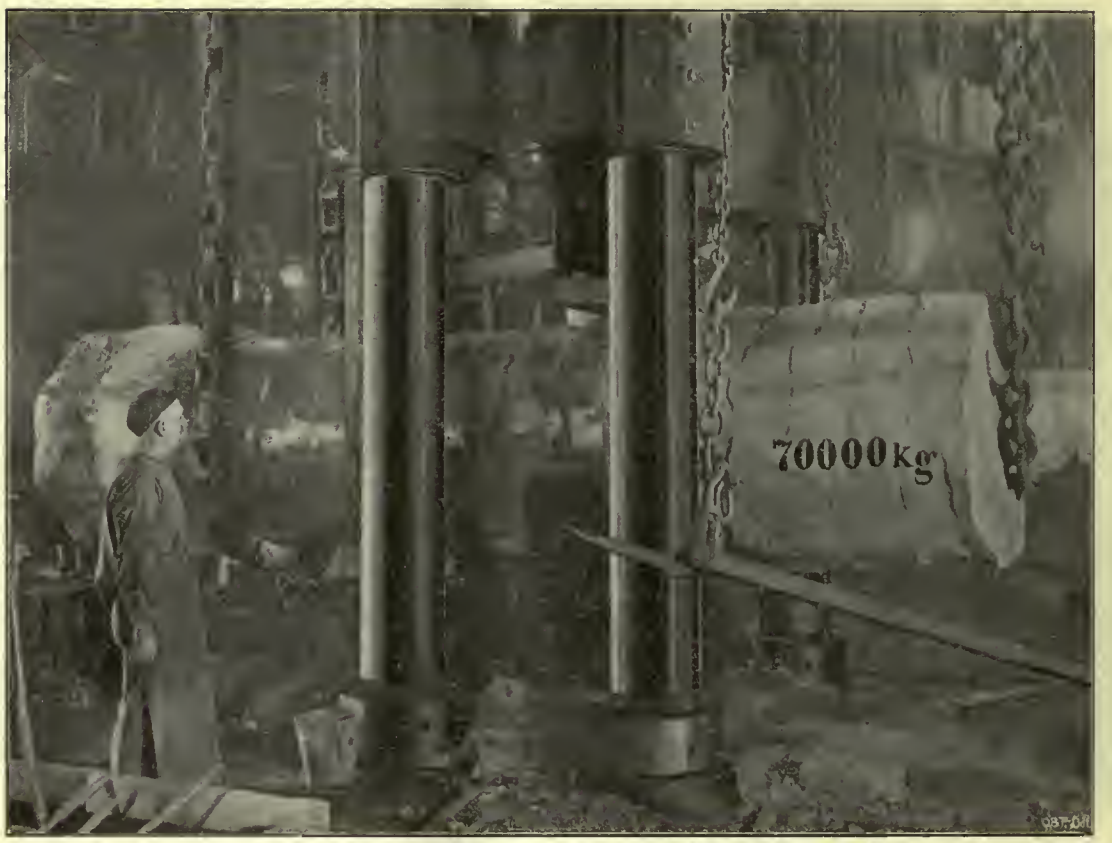
TWO BLAST FOURNACE ENGINES 3300 AND 1650 HP. FOR SOCIÉTÉ DES HAUTS FURNEAUX DE POMPEY, POMPEY NEAR NANCY.



NICKEL STEEL CRANK SHAFT AND S. M. STEEL THRUST SHAFT SUPPLIED FOR THE EXPRESS STEAMER «KAISER WILHELM DER GROSSE» OF THE NORDDEUTSCHER LLOYD.

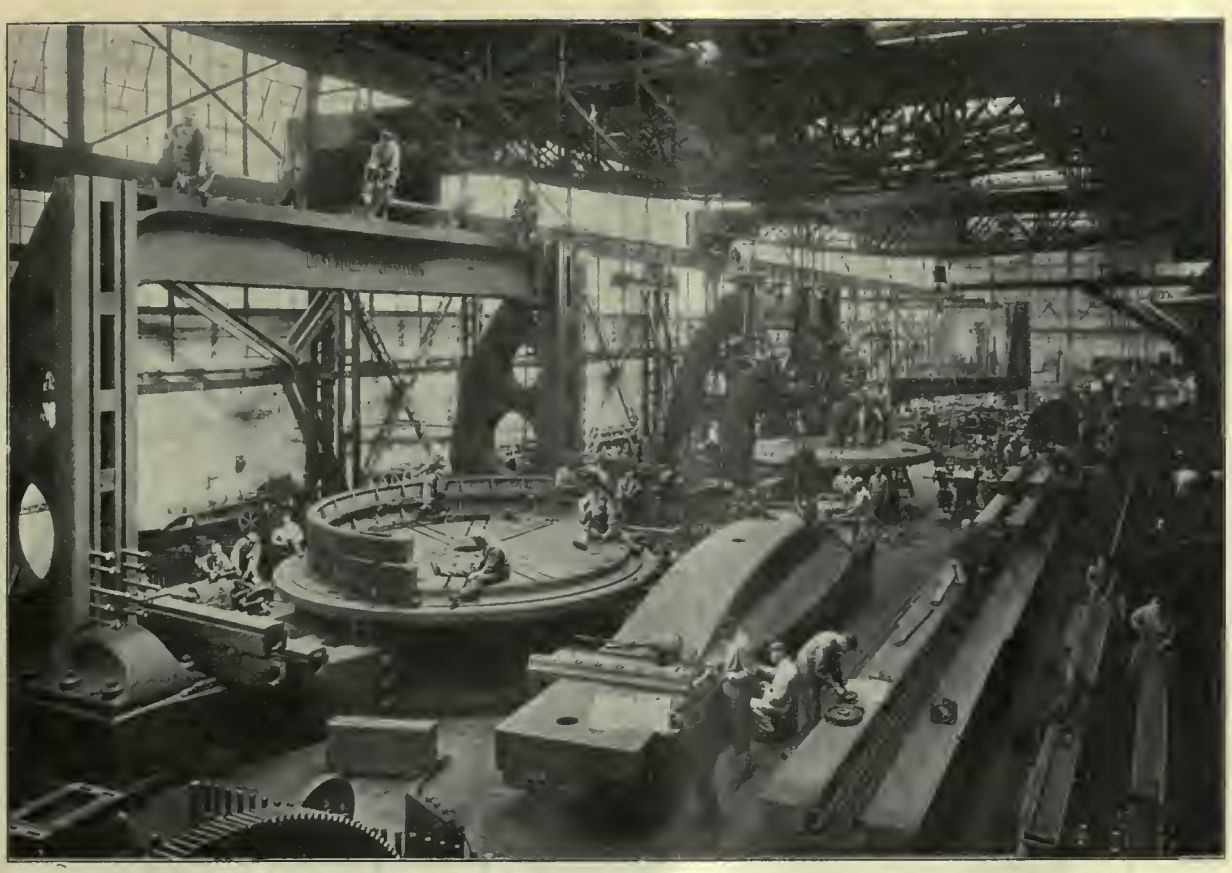


CUT THROUGH STEEL INGOTS. NO. I IS CAST BY ORDINARY PROCESS, INGOT II IS CAST BY THE RIEMER PROCESS.



STEEL INGOT OF 70 TONS WEIGHT BEING FORGED WITH A HANIEL&LUEG'S STEAM HYDRAULIC FORGING PRESS.

LINING OF A MINE SHAFT WITH SEGMENTED TUBBING RINGS.



ERECTING SHOP

ERNST SCHIESS

WERKZEUGMASHINENFABRIK, AKTIENGESELLSCHAFT, DÜSSELDORF

This firm was established on Janr. 1st 1866 as a general engineering works by the present chairman of the Company, Geheimer Kommerzienrat Dr. ing. Ernst *Schiess*. The business was converted into a Limited Liability Company on July 1st 1906.

After the end of the year 1869 the firm has confined itself almost exclusively to the construction of machine tools and up to the end of 1909 some 10 500 machines for the most varied purposes have been delivered.

The firm is also interested in a Russian concern, making machine tools, viz., the *Riga Iron Foundry and Machine Works Ltd.* formerly Felser & Co., Riga.

The grounds have had repeatedly to be enlarged, the present area being about 13½ Acres, half of which is occupied by the various buildings. The firm employs about 1000 men who are all picked among the best mechanics of the country and obtain very high wages. The office staff is about 120 engineers and clerks. The central power station contains 8 boilers with a total heating surface of 1000 m^2 and 3 steam engines, aggregating 1200 h. p. There are 80 electromotors distributed in the works.

In the iron foundry, which contains 3 cupolas, pieces upwards of 50 tons may be cast, and the cranes have a total lifting power of 225 tons.

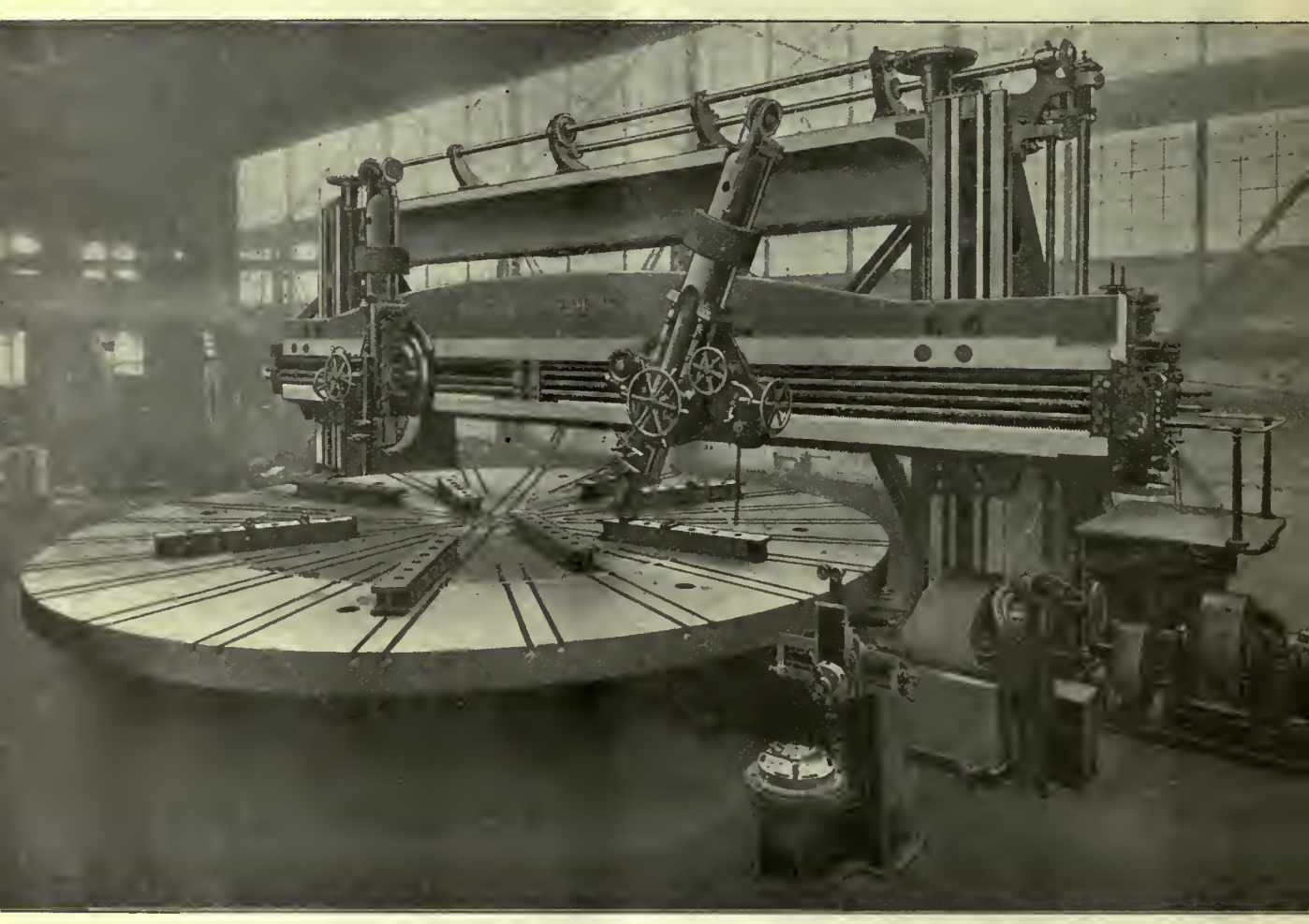
The forge is fitted with 3 steam hammers.

The mechanic's shops cover an area of 5500 m^2 and contain some 400 tools.

During my visits to various of the engineering works of this district I have had opportunities of learning how very heavy machine tools are here generally employed. I was therefore naturally very anxious to visit the works of the Schiess Company, as they are the foremost makers of this kind of tools in Germany. And, moreover, a Norwegian engineer who

kindly gave me an introduction to the Managing Director, Herr *A. Kösel* said in handing me his letter:

«Schiess has carried the production of heavy machine tools to a higher degree of perfection than any other German firm. The constructions of the firm, I must tell you, are not based upon American types, which was at first the case with the German makes of medium and small machine tools. On the contrary, the firm Schiess and also the other leading German makers of heavy machine tools have always been ahead of the Americans.»



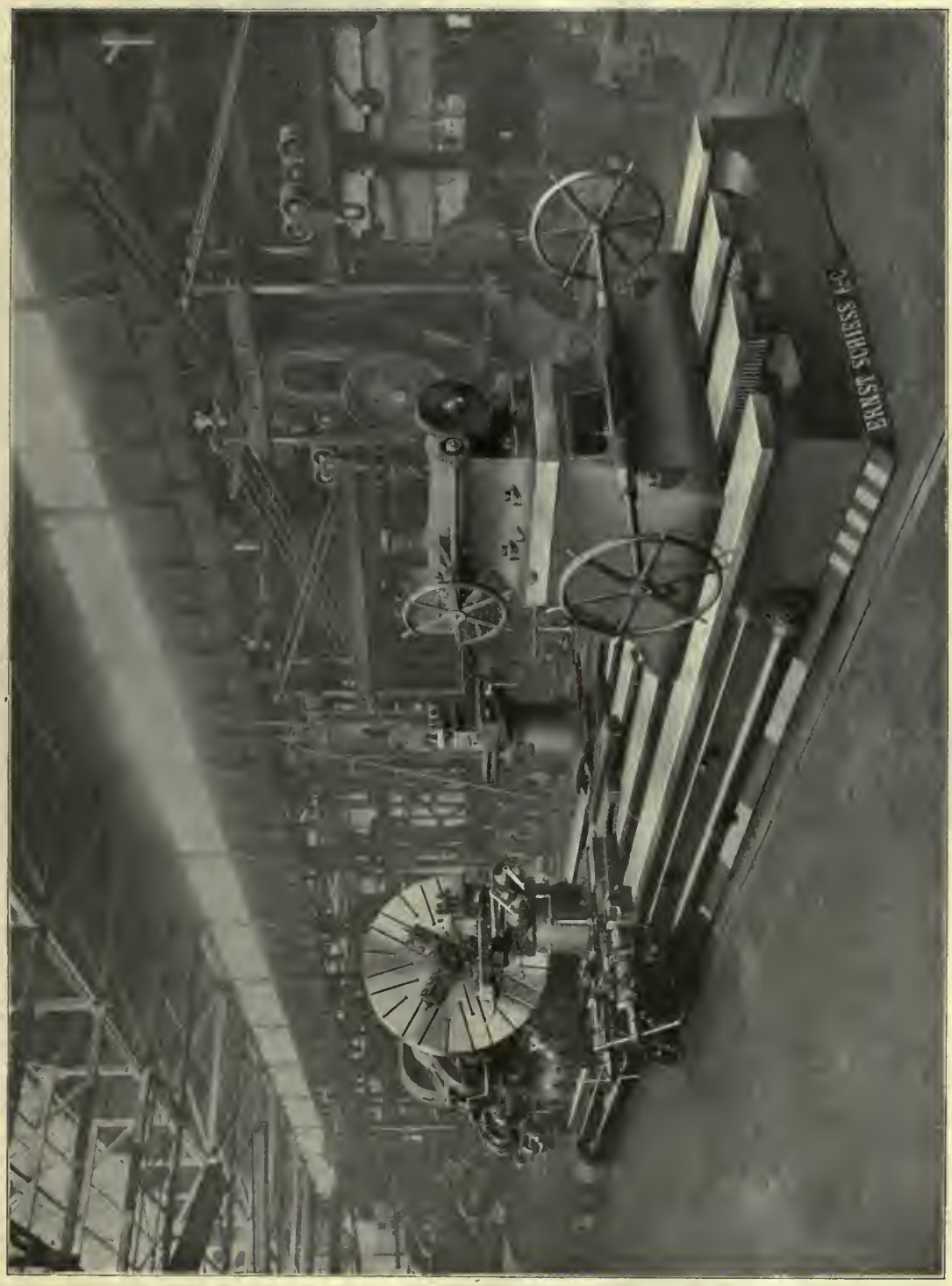
HORIZONTAL TURNING AND BORING LATHE FOR PIECES UP TO 12 000 MM. DIAMETER AND 3400 MM. HEIGHT.

As my countryman has known both the American and the German engineering trades intimately for a number of years, I place great weight upon his opinion.

I was therefore very glad when Herr Kösel told me that he would be pleased to let me see all their works — we have no secrets, he remarked, and he deputed Herr Ingenieur Friedrich Bonte to act as my cicerone.

Their erecting shop is by far the most impressive sight I have seen in any of the numerous engineering works which I have visited in the course of years in this or any other country. The accompanying pictures give only a very faint idea of the curious impression of the bigness of the thing which took hold of me on entering. These makers of heavy machine tools have themselves placed a whole array of such tools along that vast erecting shop which is 165 m long by 20 m wide. It is fitted with 3 travelling cranes of 30 tons, two of which may be combined, when necessary. There were horizontal Turning and Boring Lathes with a diameter of the face-plate of 11 m, and capable of taking pieces up to 12 m diameter and 3.4 m height; Turning and Boring Vertical Lathes of a face plate diameter of 2.2 m; Planing Machines for pieces up to 12 m in length, 4 m width and 4 m height — but why continue this enumeration? To those who are not familiar with engineering, it conveys no meaning, and for the engineer these few figures are quite sufficient to indicate the exceptionally powerful nature of the machinery here employed.

Jointly with an electrical firm the company has experimented for some time and has succeeded in constructing a planing machine which is driven directly by a reversible electrical motor without any belting or couplings. Herr Bonte demonstrated for me how the machinery acted. At the end of the stroke the



TURBINE-SHAFT TURNING LATHE. HEIGTH OF CENTRES 1650 MM., DISTANCE BETWEEN CENTRES 9000 MM. LENGTH OF BED 14 700 MM., WIDTH OF BED 3100 MM. DIAMETER OF FACE-PLATE 2500 MM. DRIVE BY ELECTRO MOTOR.

motor was automatically braked, stopped and reversed. By changing the regulating gear the attendant could alter the speed instantaneously; and the returning speed of the machine was 3 times faster than the working speed. Couplings and beltings being entirely dispensed with, experience had proved the soundness of the constructive principle, for there had been found to be a considerable saving in the cost of working. The firm were gradually altering all their own machines to this new system, and it has already delivered 60 machines of this construction.

Their prices are generally dearer than those of English makers of heavy machine tools, but the Company nevertheless did about one half of their business for export, which proved that the high quality and workmanship and the efficient construction of their tools were fully appreciated abroad.

The construction of Turning and Boring Mills or Lathes is one of their chief specialities and most of the big mills now in use have been built at their shop. The reader will get some idea of the dimensions by looking at the picture on this page. The face plate has

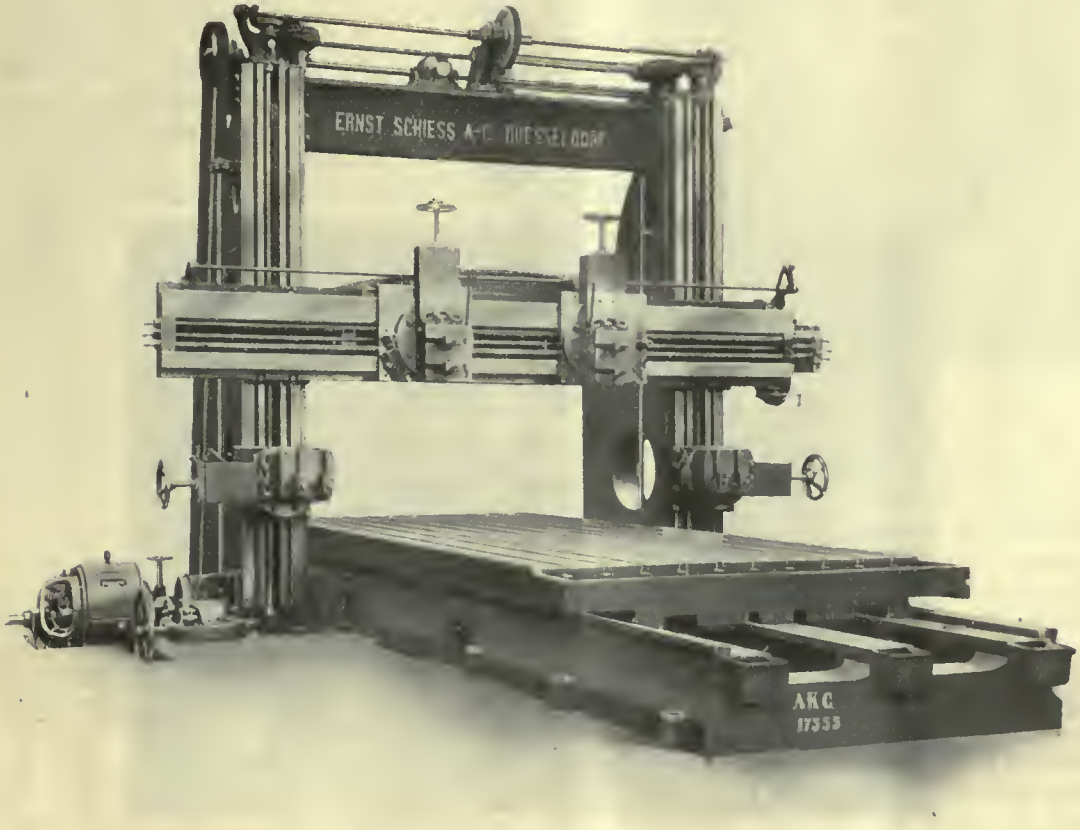
HORIZONTAL TURNING MILL.

The Company does not go in for wholesale production like the makers at lighter tools, Herr Bonte said; nearly every machine they produce is made to order, as required in each individual instance. The constructions are entirely the firm's own, and not only does the Company not depend upon American ideas, but their novelties, being published in the trade papers, are frequently adopted in America. The high quality and efficiency of the tools turned out by the Company has enabled it to obtain a market for its machines in all the principal centres of industry of the world. My guide pointed to a big planing machine in course of construction, the immense planes of which were being sharpened by hand. It is very expensive, he said, but it is resorted to in order to secure absolutely true running.

a diameter of 11 m and there are 227 men on the machine. The little machine in front represents the smallest size of this type which the firm builds. The weight of the big mill is about 300 000 kg.; more than 50 machines of this or similar sizes have been delivered. It is not, however, only the monster machines which are pushed; the company does a large trade in all the usual sizes of heavy machine tools, suitable for instance for shipbuilding and general engineering works.

The Company produces as a wholesale article grinding machines for tramway rails (D. R. P. 169 575) for grinding up the rail joints and removing the grooves and uneven surfaces on rails, and carriages for transporting these machines.

UNIVERSAL RADIAL DRILL, SWIVELLING THROUGH AN ENTIRE CIRCLE. DIAMETER OF BORING SPINDLE 100 MM., BORING DEPTH 600 MM. MAX.RADIUS 4500, MIN.RADIUS 1900 MM. MAX.DISTANCE BETWEEN PLATE AED LOWER EDGE OF BORING SPINDLE 3000 MM., VERTICAL MOTION OF ARM 1800 MM. DRIVE BY VARIABLE SPEED ELECTRO MOTOR.



PLANING MACHINE FOR PIECES UP TO 6000 MM. IN LENGTH, 3200 MM. WIDTH AND 2750 MM. HIGHT. DRIVEN BY REVERSIBLE MOTOR WITHOUT BELTINGS OR COUPLINGS.

FRIED. KRUPP AKTIENGESELLSCHAFT,

ESSEN/RUHR

To visit Düsseldorf with a view to studying the industrial development of the Rhine Province and Westfalen without seeing the works and benevolent institutions of Krupp in Essen, would have been like leaving Rome without having been in St. Peter's church.

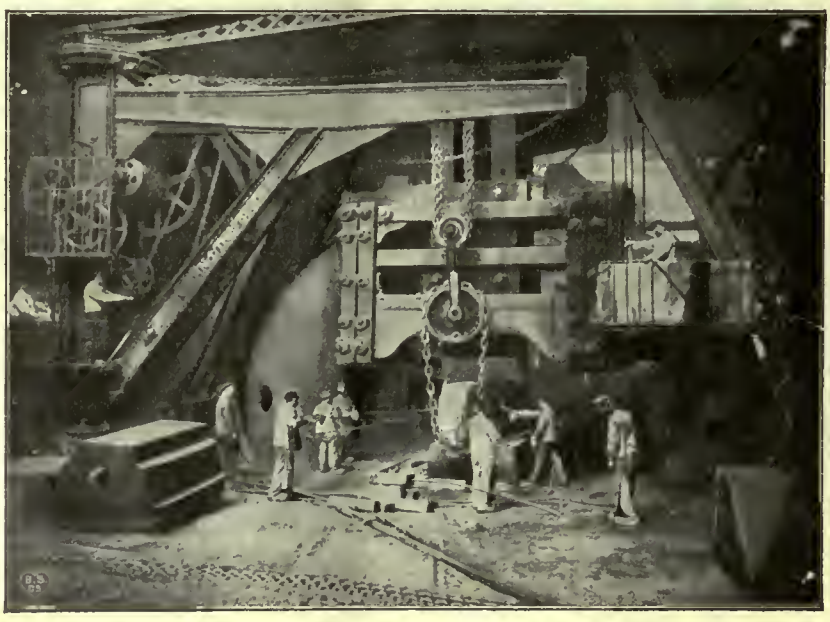
So, equipped with a letter of introduction, I presented myself at the principal gate of the works from where I was taken over the grounds by an employee of the firm.

In the morning we made the tour of the works, leaving the afternoon open for a long drive to the different workmen's colonies and the reconvalescent's homes, and I returned to Düsseldorf with a big parcel of illustrated books, containing the history of this gigantic undertaking and detailed descriptions of the many benevolent institutions that have sprung out like young branches with plenty of flowers and fruits on a fine old tree.

The marvellous success of the Krupp's steel works in Essen is due to the genius of Alfred Krupp who made technical superiority the solid basis upon which he built up the business of the firm.

By always maintaining this superiority he, and after him his son Friedrich Alfred Krupp, have been able to develop this undertaking to such an extent, it has become so large, so many sided, so self containing, that it is almost impossible to conceive how this immense organisation can be the work of these two men only. At least I could not help myself, but a feeling akin to that of visiting an old historic town took hold of me, that what I saw around me was the outcome of nature's own inherent forces, to which, however, the master mind of Alfred Krupp had given the direction.

In the period of about 60 years which has passed since the business of the firm commenced to grow rapidly, there has been an almost uninterrupted technical evolution in the steel trade. During the whole of this period of more and more rapid progress the firm Krupp has always been in the foremost rank, building and re-building has constantly been going on, but so rapidly has the business grown, that no sooner was a period of exceptional building activity ended than new and much larger extensions of the works had to be planned. The business has, for instance, quite outgrown the accomodation in the present office buildings, although these are comparatively modern, and at the commencement of our tour of inspection we passed a part of the new and palatial administration buildings which are in course of erection.



«OLD FRITZ» 50 TONS STEAM HAMMER.

No matter how much capital a firm may have at its disposal and how up-to-date its engineering and architectural departments may be, the modernisation of vast works like these must necessarily be a matter of years, when a gigantic business has to be continued without interruption during rebuilding. It is just the same which one sees in old, but rich and expanding towns, like Køln for instance;

small houses, even if comparatively new, are pulled down to make room for new, large and expensive palaces, but it is not possible to pull all the buildings in the city down simultaneously. The city grows year by year and so do these Krupp's steel works in Essen; they have become a living and growing organism, vibrating with intensive and expansive energy.

The hammer works with the «Old Fritz» 50 tons steam hammer, dating from 1861, and the Bessemer works, built in the period 1861—1865, are highly interesting because they represent great landmarks in the progressive history of the firm. At the time when they were started it was an enormous technical advance, although they now seem rather old fashioned compared with other parts of the works. The buildings which covered an area of only 3,05 ha in 1851—1855, had grown to 13,35 ha in 1865, and in the same time the number of workmen had increased from only 860 in 1855 to 2000 in 1861 and 8000 in 1865.

But what a contrast, when we reached the largest of the Martin works with 10 open-hearth steel furnaces and planned with the most up-to-date arrangements.

Or, to take another example, what a progress from the «Old Fritz» to the modern hydraulic forging presses, the biggest of which have working pressures of from 5000 to 10000 tons.

The engineering shop which we visited was also quite new and as large as the space at disposal would permit; although it might evidently have been still larger, for it was crammed full of the biggest machine tools which are to be had; yet these tools seemed quite moderate sized when compared with the enormous pieces of steel which were operated upon.

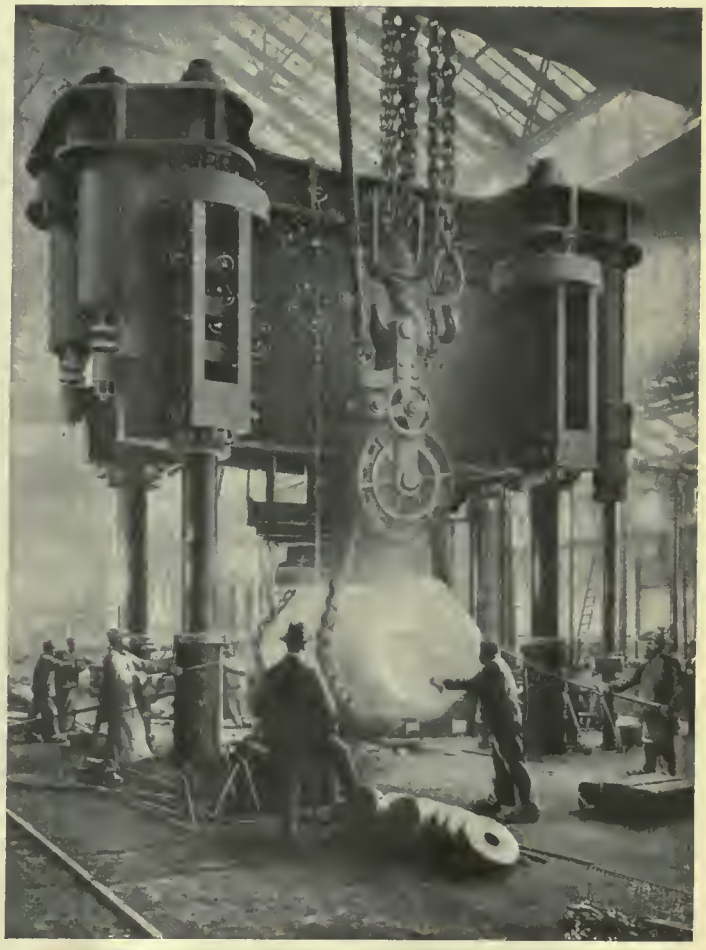
What interested me more than anything else was, however, the socalled «Schmelzbau» or crucible steel foundry, which has been extended in 1888 to its present dimensions. The production of crucible steel was commenced here by Krupp in 1818 at the same time as the works were removed from Altenessen to their present site in Essen and crucible steel is thus the oldest speciality of the firm.

Crucible steel is produced by smelting a mixture of suitable raw materials (steel and admixtures) in regenerative gas furnaces in hermetically closed crucibles.

For crucible steel only the very best raw materials are used; these are produced entirely by the firm itself, commencing with the iron ore from their own mines. Crucible steel excells by the purity of the material, and ingots of the same, even of the greatest sizes, are absolutely homogenous in texture, compact and of a uniform quality, characteristics which cannot be obtained so realiably by any other process of steel making.

The Krupp's crucible steel foundry, covering an area of not less than 18 437 sq. m, is the largest in the world. There are 18 furnaces and with about 2000 crucibles, holding 46 kg. of steel each, castings up to 85 000 kg. may be made. When we arrived, a 50 tons casting of nickel steel for a gun was about to take place.

Not less than 300 workmen were running between the furnaces and the ingot form underneath the middle of the vast room; two and two men carried the white hot crucibles between them. It is a highly dangerous work and requires the utmost discip-



HYDRAULIC FORGING PRESS.

line and sense of solidarity among the labourers, as it may easily be imagined what a calamity would happen, if 46 kg. of molten metal were overturned among so many men. Four big and many small castings of crucible steel are made in every 24 hours and several hundred different kinds of steel can be manufactured.

The crucible steel is used for all those products where safety is of the utmost importance, particularly for artillery pieces, engines, mining machinery, large rolling mills, and other kinds of machinery where great strenght is required, as well as for such machinery parts where the smallest weight combined with the greatest reliability is desirable f. i. locomotive

tyres and axles, crankshafts for small explosion motors and finally for tools, springs &c.

To see this works during casting time leaves an impression which is not easily forgotten.

The principle of the firm has been to use, whether in new or old buildings, only that machinery and those methods which have at each epoch been the best and most up-to-date, and the most efficient engineering staff, with the object of turning out at a minimum of cost the greatest quantity of the best products of the day.

CRUCIBLE STEEL WORKS «SCHMELZBAU».

It is this unflinchingly continued policy of efficiency and quality which is the secret of the firm's unbroken record of progress.

If space had permitted I would have liked to reproduce here in extenso the summary of the firm's history from one of the books which I received, but I must confine myself to giving the salient points.

Friedrich Krupp who was born July 17th 1787, started with partners the firm *Fried. Krupp* on Nov. 20th 1811 for the production of cast steel.

His son *Alfred Krupp* was born April 26th 1812.

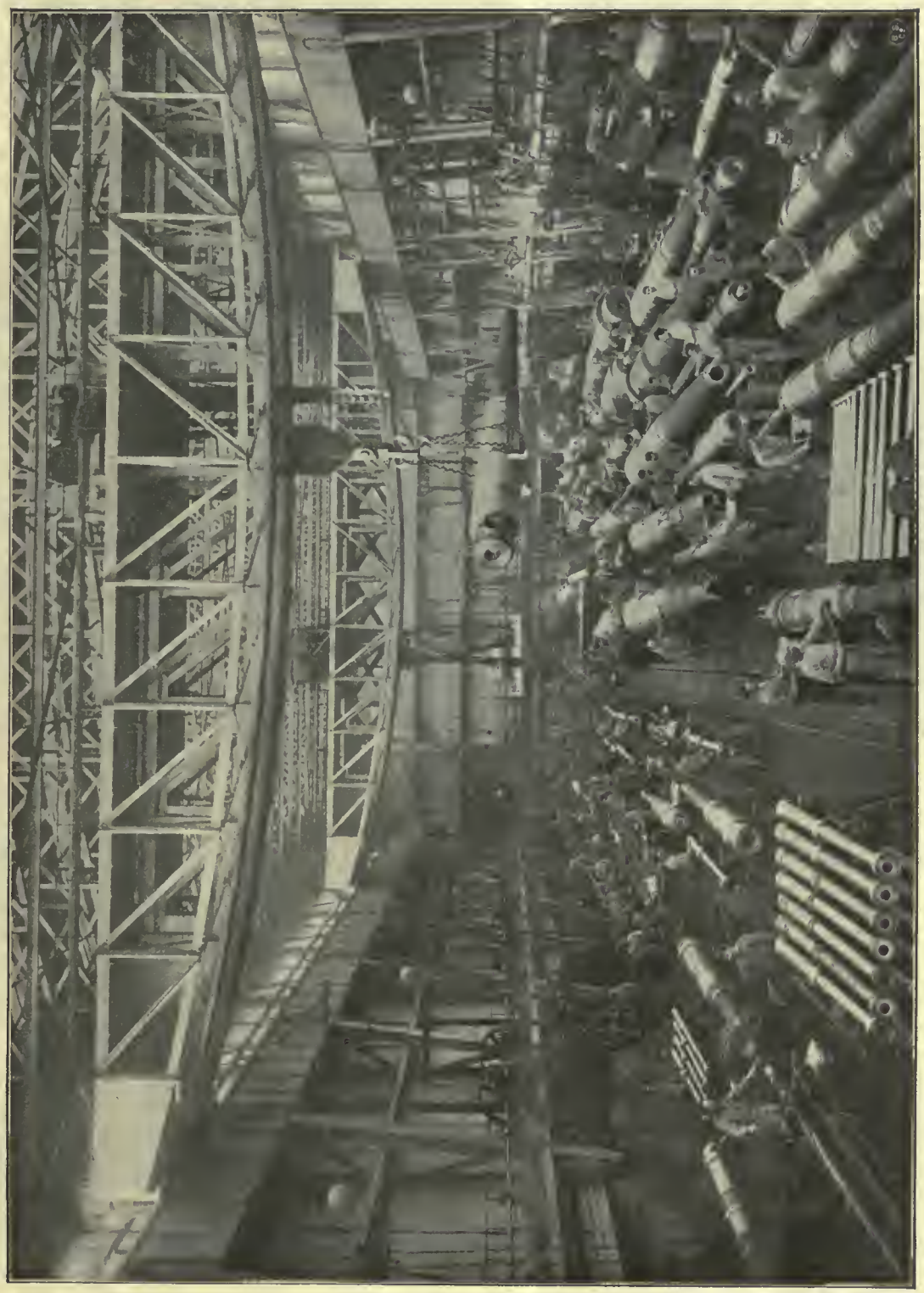
The first works was built at Altenessen near a small waterfall.

In 1816 Friedrich Krupp who possessed some capital took over as sole proprietor the works, which had in the meantime been stopped, and in October of that year he made the first delivery of crucible steel of his own make.

In 1818 he removed, as previously mentioned, to Essen and built at the same time a small house for the use of his foreman, the present «Stammhaus». The business met, however, with so many obstacles and difficulties and he soon found himself in such straitened circumstances that he was compelled to make this little dwelling his own home. Financial troubles and his illness brought the works to a temporary stand still in 1823, and on the death of Friedrich Krupp which took place on Oct. 8th 1826 his 14 years old son *Alfred* had to undertake, for his mother, the management of the steelworks which employed at that time 7—seven—workmen.

When the first steam-engine, a double high pressure engine of 20 hp, was started in the year 1835 for driving hammers, machine tools and grinding machines, the number of employees did not yet exceed 67. Alfred Krupp took over the firm for his own account on Feb. 24th 1848. At that time he did not employ more than 74 men, but the number had been 122 in 1846.

At the first International Exhibition in London in 1851 the firm exhibited a 6 pounder gun of Cast



GUN SHOP.

Steel (jacketed barrel) and a caststeel ingot of 4 500 pounds. At this time the first great extension of the works took place; a rolling mill, a new hammer works, a large engineering works, a puddling works and a foundry were built; raising the area of the buildings to 3.05 ha. and the number of employees rose to 700.

In 1854 *Fricdrich Alfrcd Krupp* was born.

From about this time onwards the business of the firm has grown with leaps and bounds, technical improvements keeping pace with the requirements of the times, and gradually the firm aquired their own iron ore and coal mines. In 1873 compared with 1850, the steam hammers had increased from 2 to 71, the steam engines from 2 to 286, the property in Essen from 4,53 ha. to 306,16 ha., the buildings from-

«STAMMHAUS».

covering 0,4 ha. to 35,06 ha. and the total number of employees had risen to 15 000 of which 12 000 in Essen.

Alfred Krupp died July 14th 1887.

The business has grown continually.

In 1893 the firm aquired the Grusonwerk, steel works in Magdeburg-Buckau, established in 1821 by Herman Gruson.

In 1896 the firm Krupp made a contract to take over the working, for their account, of the shipbuilding yard Germaniawerft, Kiel-Gaarden, which had been esablished in 1822 in Berlin by F. A. Engels and was transferred in 1865 to Kiel. In 1902 the lease was cancelled and the Germaniawerft was purchased by the Krupp firm.

In 1900 the number of employees had grown to 45 000, of which 27 000 were employed at the Essen steel works.

On Nov. 22nd 1902 Friedrich AlfredKrupp died.

He had been the sole proprietor of the firm; undivided the business was inherited by his eldest daughter, Miss *Bertha Krupp*. In accordance with the wish of the deceased the firm was changed on July Ist 1903 into a limited Company, the shares of which, however, are all held by Miss Krupp, who married, on Oct, 15th 1900, Herr *Gustav Krupp von Bohlen und Halbach,* who has entered the Aufsichtsrat of the Company as President. The share capital is Mk. 180 000 000.

Already in 1862 Alfred Krupp had established a collective procura, or a kind of board, where the heads of the various departments had seats.

The management of the Company rests with a board of directors, which consisted on January 1st 1911 of 11 members, 10 of whom lived in Essen and 1 in Magdeburg; the last named gentleman being also President of the Fried. Krupp Grusonwerk Ltd., while the Germania Schiffs- und Maschinenbau Aktiengesellschaft was amalgamated in 1902 with the general business of the firm.

The technical and commercial improvements and the growth of the business has continued at an accelerating rate since the conversion of the firm into a Limited Company. On May 1st 1910 the total number of employeers of the Krupp works amounted to 68 905, including an office staff of 6840, distributed as follows:

Steel works at Essen with prooving grounds	37 848
Coal mines	10 035
Iron mines	4 763
Middle Rhine iron works	1 075
Shipping Agency Rotterdam	49
Friedrich Alfred iron works	5 665
Steel works Annen	1 027
The Gruson works	3 939
Germania shipbuilding yard	4 504
	68 905

Two monuments to Alfred Krupp have been erected in the town, one at the entrance to the works; I passed it with reverence, but to this great general of industry might well be applied the proud works inscribed in St. Paul's cathedral to Christopher Wren, the architect: «*si monumentum quæris, circumspice*».

No sooner was the success of the business of the firm an established fact, than the proprietor commenced the establishment of benevolent institutions. In 1853 a fund was created to gtve assistance to his workmen in illness and upon death.

In 1861 the firm commenced building houses for their workpeople, and Alfred Krupp continually extended and increased his institutions for the welfare of his workmen.

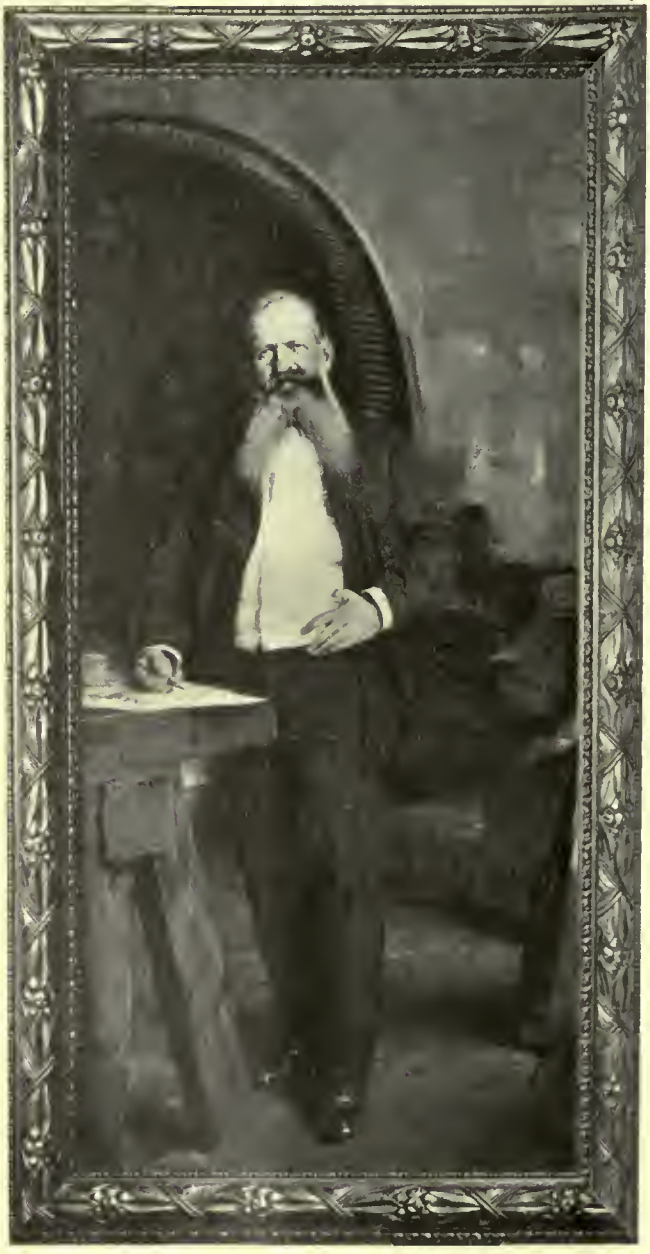
But the «Wohlfartseinrichtungen» of the firm Krupp, which are not less remarkable than the works themselves, and which comprise workmens houses, funds

for giving help in sickness, large pension funds, schools, supply stores, libraries, the colony «Altenhof» where old and invalid workpeople get at free home for their lifetime, savings bank for the employees, reading rooms, flour mill and bakery, dining rooms &c. &c. — these and many other benevolent institutions owe their existence mainly to the kind heart and broadminded liberality of Fiedrich Alfred Krupp, who has thereby made himself a monument *aere perennius*.

COLONY «ALTENHOF».

RHEINISCHE METALLWAREN- UND MASCHINENFABRIK, AKTIENGESELLSCHAFT,

DÜSSELDORF



GEHEIMER BAURAT EHRHARDT

This firm which was established as recently as in 1889 by the present chairman of the Company, Geheimer Baurat Dr. *Heinrich Ehrhardt*, and which at first only employed a few hundred workmen, has become in that short time, not only the largest industrial concern in Düsseldorf, but one of the most important in the whole of the province.

Born in Zella St. Blasii, Novbr. 17th 1840, Heinrich Ehrhardt started in life as an apprentice and afterwards a workman in the employment of Dreyse in Sommerda, known all over the world as the inventor of the needle gun. He has become a millionaire; for his services to the fatherland he has been made a Geheimer Baurat, but he remains on terms of familiar friendship with his old camrades from Dreyse's workshop.

Ehrhardt has been an inventor on a large scale; among a number of improvements or quite original ideas for machine tools he himself apparently attaches most importance to his circular saw for cutting cold iron under constant pressure, for his telegraphic address is: «Kaltsäge».

Unlike so many inventors he combined with his great mechanical talent a genius for business, and as he was therefore able to command capital, he was enabled personally to fructify his ideas. In 1879 he started business on his own account, establishing engineering works at Zella St. Blasii in Thüringen.

Having received in 1889 an important order for cartridges for the infantry rifle, pattern 88, he founded, in co-operation with the German War Office authorities:

Rheinische Metallwaren und Maschinenfabrik A.G, Düsseldorf.

The orders received at this factory from 1889 to 1892 for more than 200 millions of cartridges show to what extent and how rapidly this new undertaking gained the confidence of the Secretary of State for War.

Very soon after this works was started trials were commenced for the manufacture of hollow bodies, required for artillery purposes, and in connection

therewith Geheimer Baurat Ehrhardt made his most epoch making invention, the *Ehrhardt compression process*, which was patented in 1891.

Essentially this process consists in compressing the metal into a mould by means of a punch *c*. To obtain a hollow cylinder an ingot or a block of steel *a*, of square section, is introduced at clear red heat into a mould of a suitable diameter *b*. The diagonal of the square section of the ingot should equal the diameter of the mould; upon the latter a lid *d* is arranged which serves as a guide to the punch *c* which is then forced into the ingot by means of an hydraulic press. The punch is of such diameter that the metal which it displaces in penetrating fills up the four segments *e* between the ingot and the walls of the mould. This makes it possible to produce the desired piece of work with the minimum quantity of metal, and the pressure tends to greatly improve the quality of the steel by making it to a high degree homogenous in texture and very hard and tough. As the metal yields the punch easily penetrates. The vessel formed by this process is illustrated here. The base of the interior naturally takes the form of the head of the punch. The mould is locked at the bottom by a plate *s*.

The roughly formed vessel is chilled at the top by placing it in a vessel containing cold water or oil; it is thereupon again placed in the press, the plate *s* is withdrawn, and the punching tool continues its stroke. Owing to the head of the vessel having been chilled it is forced by the punch to pass successively through the dies *d d1 d2*, each having a smaller diameter, which gradually give the vessel the desired form and diameter. In the same manner prismatic or irregularly shaped hollow bodies may be made by means of special moulds.

Modified to suit different purposes this ingenious process is used in all the works of the Rheinische Company.

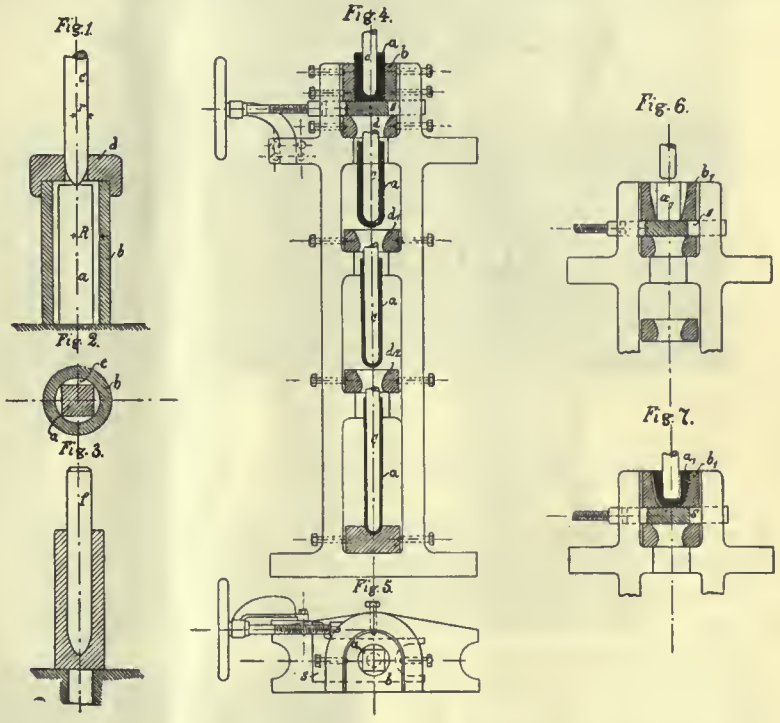
Ehrhardt was not, however, satisfied with using this method for the production of shells only. Continuing his experiments he succeeded in making gun ingots by his compression process, and in 1897 the German War Office ordered from the Rheinische Metallwaren- und Maschinenfabrik a considerable number of guns of this description.

As the business of the Company increased and therefore also their consumption of raw materials, it became so difficult to obtain sufficient quantities of quality steel, that the business was sometimes brought almost to a stand still. The firm therefore acquired in the year 1896 the two steel works in Rath near Düsseldorf called: Rather Metall Werk formerly Ehrhardt and Heye, and these now form:

The Rath Branch Works

where the Company manufactures high class steel for its own use as well as for sale.

It became necessary for the Company to make a new extension of their works, when they undertook the manufacture of guns. Indeed it was becoming particularly difficult to obtain the supplies necessary for the equipment of guns, as the Rheinische Company found itself face to face with a sort of manufacturers' trust. Consequently, encouraged by receiving some important foreign orders, the Company acquired in 1901 the works of the Arms and Ammuni-



THE EHRHARDT COMPRESSION PROCESS.

tion Company, formerly occupied for many years by Dreyse at Sommerda, for the manufacture of that ingenious weapon, the needle gun. At this

Sommerda Works

which also comprised a small-arms factory, the Company commenced first the manufacture of fuses, afterwards of small artillery equipment, such as horsecloths, battery telescopos sc.

The necessary consequence of these various extensious was the opening of a

Shooting Range for Guns

at Unterluss on the waste land of Lüneburg.

In the years 1894/95 and again in 1897 the German War Office authorities requested Geheimerat Ehrhardt to undertake the manufacture of ammunition waggons. Therefore on Decbr. 3rd 1896

FIELD GUN.

The Eisenach Carriage Works

was started, having wheel making shops and a department for building motor vehicles for war service and also for ordinary requirements.

Contemporary with starting this carriage works the Rheinische Metallwaren- und Maschienenfabrik acquired the *Ehrhardt-Hausner Patent* relating to long recoil field guns which gave an impetus to the production under the said patent.

By his energetic development of this ingenious new form for artillery, the long recoil gun, which could not be done without great sacrifices of labour and money, Geheimerat Ehrhardt has secured for himself an honourable place in the history of artillery evolution. Under his patent the gun is placed upon a «cradle». This cradle constitutes the sliding track for the piece and it contains the hydraulic brake and the counter recoil-springs. It is constructed of a weldless steel tube of cross section, manufactured by the Ehrhardt process. To the upper part are attached the guide rails for the claws of the piece and in the interior the guiding rails for the spring discs of the brake cylinder are economically arranged. The entire arrangement is illustrated by the above picture of a field gun.

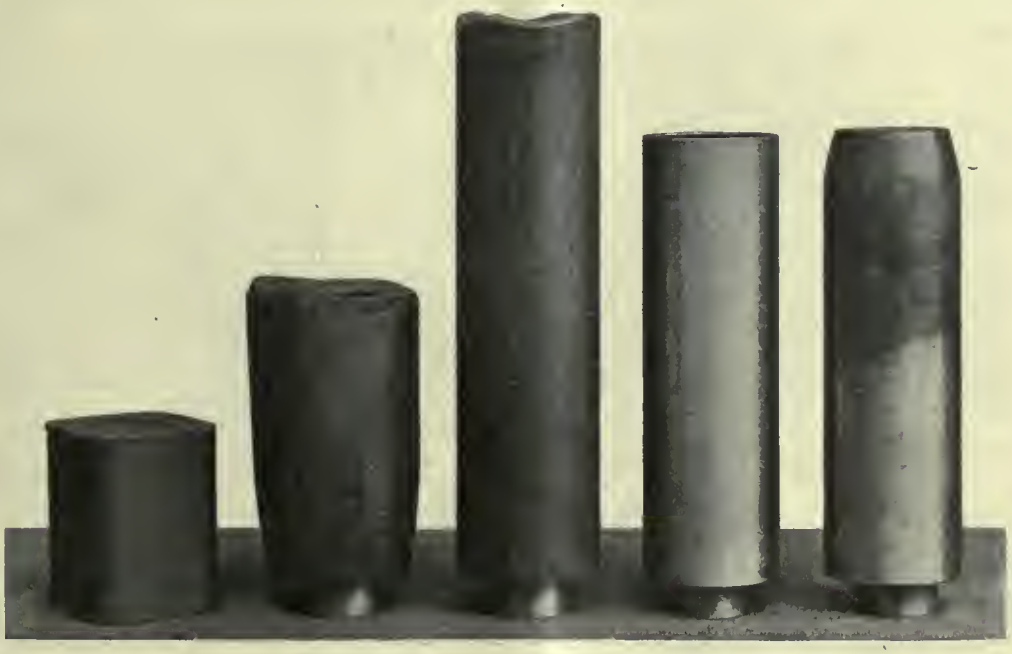
GUN BEING DRAWN BY MEANS OF ROPES TO THE TOP OF A HILL.

THE GUN DESCENDING WITH THE AID OP ROPES.

STOPPING ON THE WAY DOWN.

TRIALS IN NORWAY, APRIL AND MAI, 1901.

This powerful piece of artillery which has been perfected by Geheimerat Ehrhardt has now been adopted throughout the World. But at first it was received with considerable scepticism. «At the beginning of the year 1901» wrote the Chief Danish Artillery Officer, General von Wagener, in the «Tekniske Forenings Tidsskrift» Dec. 1901, «a report that 18 batteries of field artillery («made in Germany») had just been purchased by the English Government caused intense astonishment, even far beyond the countries of Europe, and became the subject of questions in the British Parliament. Thus attention was directed to the individual who had sent, so to speak, coals to Newcastle».



APPLICATION OF THE EHRHARDT COMPRESSION PROCESS TO THE MANUFACTURE OF PROJECTILES; STAGES OF MANUFACTURE.

One of the first foreign Governments to recognise the great value of this new weapon was that of Norway, which ordered in July 1901 22 batteries of field guns.

In order to be able to manufacture also heavy guns advantage has been taken of the remarkable efforts made by the

Düsseldorf-Reisholz Forge and Rolling Mills Company (Press- und Walzwerk)

At this works the Ehrhardt compression process is used on pieces of the greatest dimensions and the pressess and other arrangements are on a correspondingly big scale, making it easy to convert ingots of 10 tons into hollow bodies.

At this works is also employed another important invention by Ehrhardt, the transforming of bored ingots into boilers, steam turbine cases and similar objects.

Heinrich Ehrhardt's Works

Zella St. Blasii, Thüringen.

In this works which belongs to Geheimerat Ehrhardt personally it has been found possible, owing to the exceptional skill of the workmen in this locality, to carry on the most delicate work in connection with artillery construction. The stay-at-home character of the Thuringian population who dislike a change of residence, rendered it impossible to transfer an adequate number of capable workmen to the Rhine province.

The works which to-day form the *Ehrhardt Establishments* employ at present 360 officials (draftsmen, clerks &c.) and 7563 workmen, who are distributed among the different works as follows:

Düsseldorf Works	102	3500
Rath Works	57	950
Sommerda Works	36	843
Unterluss Range	6	100
Eisenach Carriage Works	80	1200
Heinrich Ehrhardt, Zella	39	560
Düsseldorf Reisholz Forge and Rolling Mills Co.	40	400
	360	7563

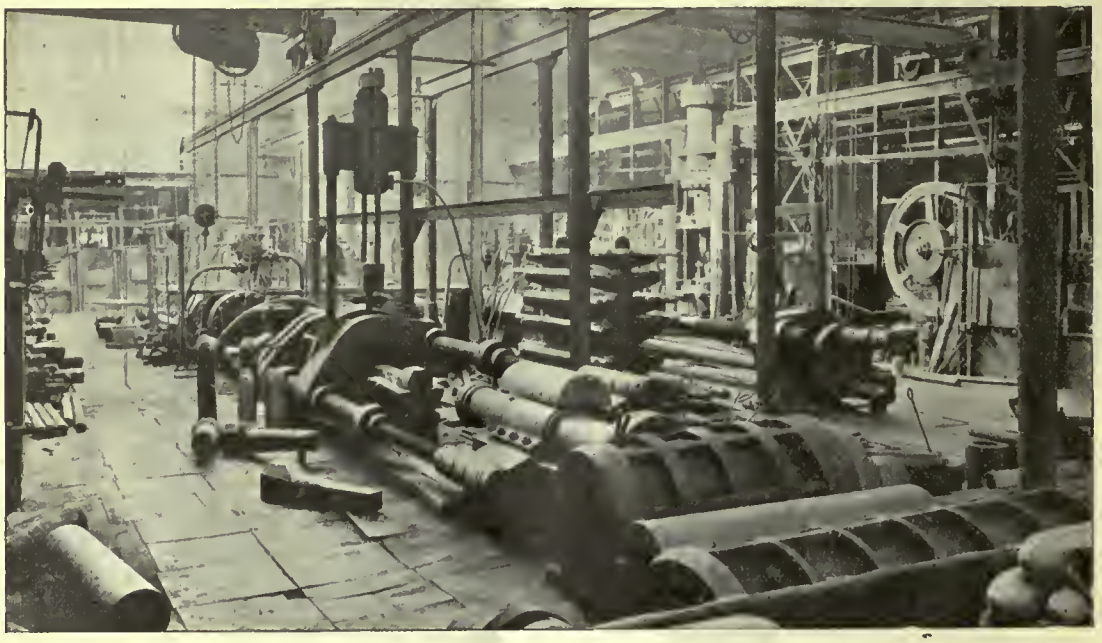
The Managing Director, Herr G. *Müller,* afforded me every facility for studying the works and gave me for cicerone Mr. Carl *Bødtker,* a young Norwegian engineer employed in their gun construction departement.

We first visited the Düsseldorf works at Derendorf. I was shown the Ehrhardt compression process

in operation. The hydraulic pressure works contains 20 hydraulic presses, 3 of which have a pressure of upwards of 800 tons, and further 8 accumulators of which 2 have a stroke of 7.5 m by 305 mm diameter of the pistons.

The Ehrhardt process is used for the manufacture of guns and shell and many other warlike purposes, but also for a variety of peaceful purposes, as for instance weldless locomotive and engine tubes, high pressure gas-cylinders for liquid carbonic acid, different kinds of tubes &c.

This process must effect a revolution in the manufacture of guns, for not only is much time saved, but which transformed the original vessel with tick walls into a long weldless tube. At the same heat a hook is forged with a machine hammer which admits of the tube being grasped by a drawing tool so as to continue the operations to which it must be subjected. To regulate the thickness of their walls the tubes, which have up the this point been worked hot, are taken to the cold drawing press, in which the thickness of the walls of the tubes for boilers or for water-pipes is reduced by a series of drawings to the requied dimensions. When once the movement is started the punch, exactly centred and securely guided, penetrates the tube without any deviation.



PRESSING SHOP I.

it has the additional advantage of greatly increasing the density of the metal in the part of the gun near the surface of the bore, thus increasing the resistance to gas pressure and to deterioration by burning and erosion. It also guarantees security in the case of a projectile exploding in the bore of the gun. Exhaustive resistance tests have been carried out which have proved this fact.

I was highly interested in watching the process; it seemed to be quite child's play, so easily did the punch pass through the red hot metal. However, when we afterwards came to the engine house, I saw that enormous power was required, for the great engine nearly came to a standstill while a stroke lasted, and in the greatest of the presses the actual power of the engine has to be supplemented by the stored -up energy in the accumulator.

In the shops for the manufacture of weldless tubes the process is divided into hot-drawing and cold-drawing. The cupped vessel first obtained was taken to a hot-drawing press, where a long punch forced it with great speed through a numerous series of dies

There are also arrangements for bending the tubes for the boilers of torpedoboats and similar purposes. Finally, a number of cold saws out the tubes to the required length.

In another works tubes were manufactured by bending sheets of iron; afterwards they were heated in a furnace and passing through a rolling mill they were instantly welded, this process causing a most peculiar hissing sound. These tubes are suitable for gas pipes and other pipes which have only a low pressure to sustain.

In the gun fitting shop I had an opportunity of following the guns, which had been compressed by the Ehrhardt process, through the subsequent operations. These large shops are fitted up with powerful travelling cranes and a great variety ot specially constructed machine tools. The outside of the gun is as much as possible finished with the turning lathe, but a modern gun has many absesses, and quite a large variety of planing and shaping machines has had to be invented in order to reach all parts and to produce the many complicated shapings which are re-

MANUFACTURE OF WELDLES TUBES.

GUN SHOP.

quired. The interior or the bore has been formed to very nearly the required calibre at the time of compression, in the boring machine the gun merely receives its exact diameter. In consequence of the compression and the original quality of the steel the walls of the bore have an extraordinary degree of hardness and the boring is only possible when carried out with the greatest care and with tools of a special design, having a cooling and lubricating jet.

The method employed in rifling the guns was explained to me; the whole thing had to be calculated by means of higher mathematics and according to this calculation a drawing was made. From this drawing was again made a steel slide, by means of which the turnings of the shaping machine, working inside the gun, were guided.

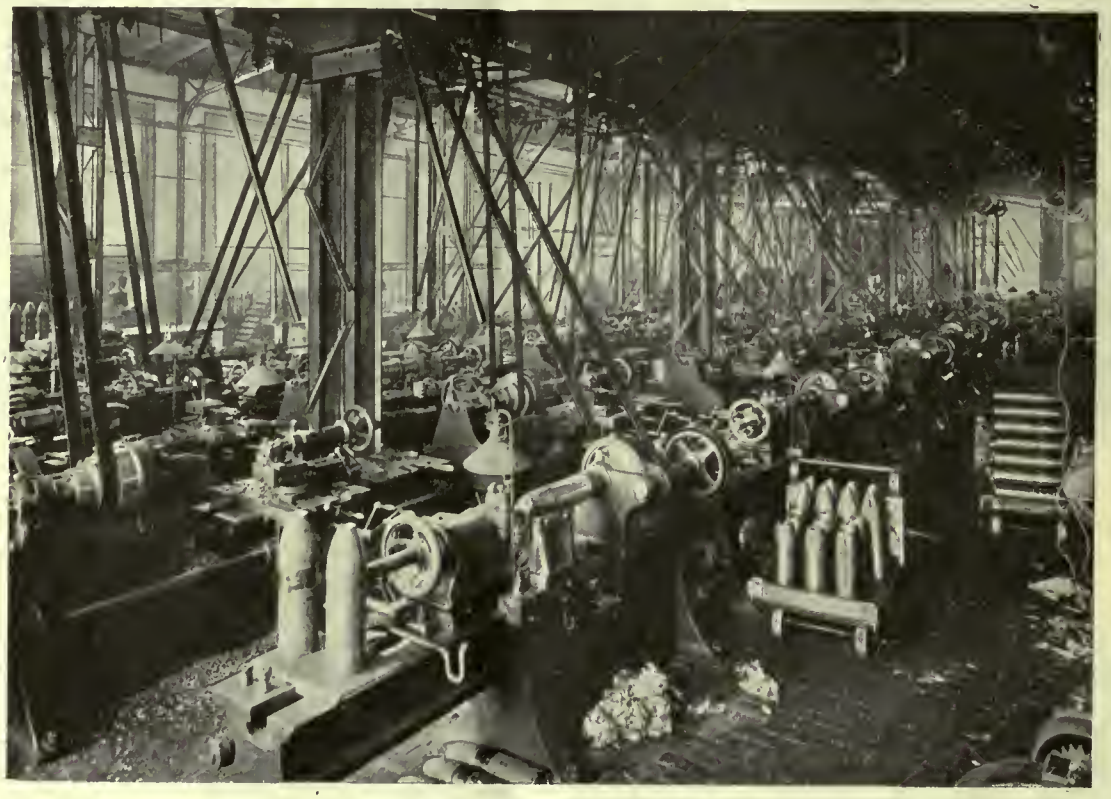
In the turning shop for projectiles I admired the minute exactitude with which the work was carried out, the latitude allowed being almost infinitissimal. Before being examined by the controlling officer of the Government, for which they are manufactured, the projectiles are subjected to the most rigid tests in the firm's own examination department, which I also visited.

In the afternoon we saw the branch works Germania for the manufacture of small-arms ammunition, where a very large number of workpeople, mostly women, are employed, although all the operations are executed by automatic machines.

Next day we went to Rath on the outskirts of Düsseldorf. The director, Herr *Pacher*, was good enough personally to conduct us over the works and explain to me the various processes.

This works comprises two shops which are connected by a railway and comprise a large and varied plant.

The steel works consists of 4 Siemens-Martin steel furnaces and 3 furnaces for heating the crucibles. The works has a producing capacity of 30 000 tons of steel per annum.



NEW TURNING SHOP FOR PROJECTILES.

We saw a large number of crucibles being emptied into a big receptacle in which the molton steel was thoroughly mixed before being poured into a patented fluid-steel press in which it was subjected to a pressure of 1250 tons. The object of this operation was explained by the director, who showed us an ingot, which had been cut in two and which had not been subjected to this pressure. When cast the steel fills the mould, but when cooling it contracts about 2 % in volume and this contraction had left an open space with very irregular walls in the middle of this piece. We were thereupon shown another ingot, that had been pressed in the fluid state and which had also been cut in two. Here it was demonstrated that the pressure on the fluid steel had so completely counteracted the shrinkage, that the entire ingot was throughout completely solid with a quite homogenous and beautifully fine texture.

For guns and other objects that require quality steel, Swedish charcoal iron is the raw materiel and

the crucible method of steel making is employed. The different steel alloys, such as nickel, chrome, tungsten, vanadium and titanium steel, are produced by carefully weighing and mixing the charge in the crucibles. These qualities are used for ordnance and its accessories, for running-out springs, for tools of every degree of hardness, for locomotive tyres sc. sc.

I also watched how steel was manufactured by the Siemens-Martin process on a large scale for commercial purposes.

The rolling mills which contain 5 mills are provided with everything necessary to produce rectangulær bars for the manufacture of hollow bodies by the Ehrhardt process (shrapnels, shells, weldless tubes sc.). The long bars were cut at red heat into pieces by means of 6 saws. About 9000 such pieces can be manufactured in 10 hours.

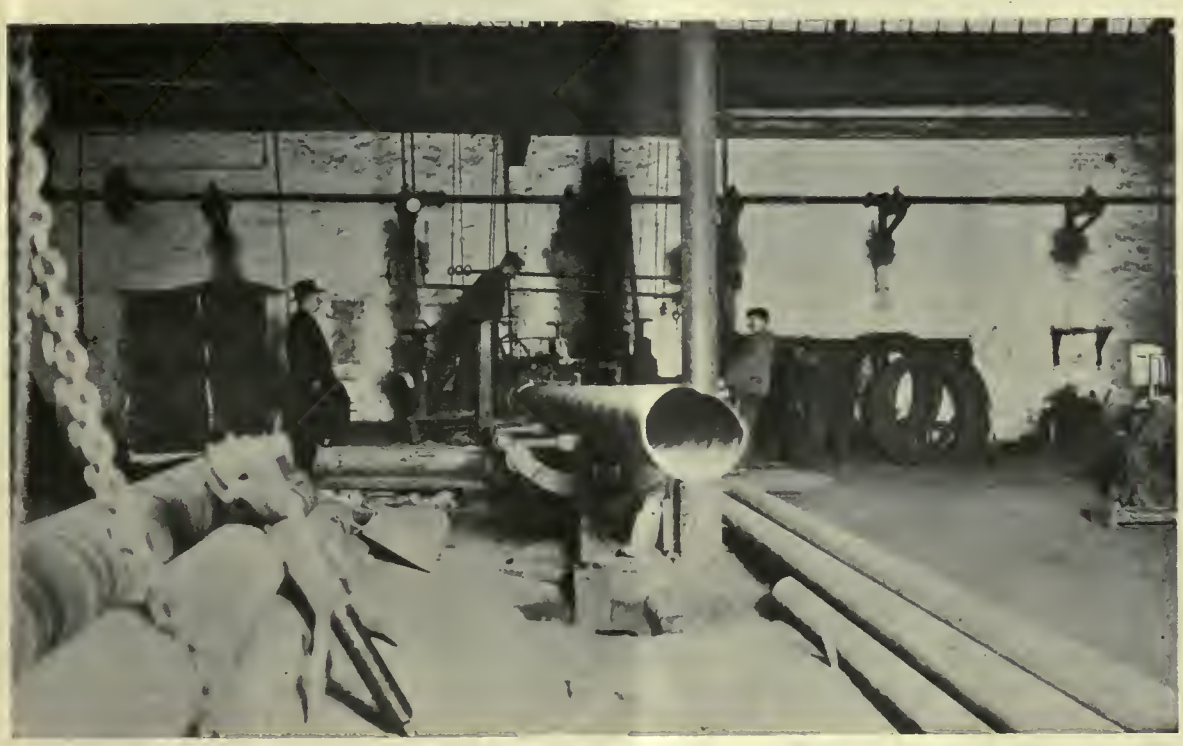
In the forging room we saw an interesting operation, the making of wheel-tyres for railway wheels. An oblong ingot of steel was hammered at red heat for a considerable time and finally, by means of a punch, a hole was made in the steel which had by that time been formed into a flat disc. On another hammer this thick ring was gradually roughly shaped and finally was compressed in a modified Ehrhardt press into its true shape.

In a somewhat similar way wheels with weldless spokes for railway engines are also manufactured by the compression process and after being finished in the turning lathe the wheel-tyre is slipped over the wheels in a red hot state; when cooling it contracts and is thus fixed indissolubly to the wheel.

I did not actually see the manufacture of ordnance but I saw the hammered ingots.

The wheel mounting shop contains a large number of heavy machines for shaping and finishing the wheels, axles and tyres, and I saw a number of railway wheels which were being made ready for shipment to Germany, Italy, Japan.

An interesting department of the works was that for the manufacture of spiral tubes. Long bands of sheet iron were rolled to form the spiral tubes, being at the same time welded by means of a jet of hydrogen flame in three authomatic machines of an ingenious design. These tubes are both light and long and are very suitable for a number of purposes.



MANUFACTURING SPIRAL TUBES.

In the course of only one generation a number of works have been created which have individually been evolved to a high degree of perfection. Acting together the Ehrhardt works have become one of the leading industrial concerns in the world for the production of modern artillery upon quite novel lines. And in addition these establishments turn out large quantities of steel work for peaceful purposes. And yet the man, who has started and still controls this great undertaking and who commenced his career as a working man, is comparatively young — it is truly wonderful. It reads like a fairy tale, but it is a very substantial fact.

FARBENFABRIKEN VORM. FRIEDR. BAYER & CO. WORKS IN ELBERFELD.

FARBENFABRIKEN VORM. FRIEDR. BAYER & CO.

ELBERFELD

From time immemorial man has practised the art of dyeing textile fabrics by the use of the colouring matter contained in different plants, such as Indigo and the Madder Root. At the beginning of last century the increasing cost of the natural colouring matter and also different drawbacks attending their use caused a number of eminent chemists to subject the various plant colours to searching investigations. Thanks to the great development which chemical science and experimental methods had at that time already attained, these investigations have borne splendid fruits.

In 1826 Aniline, an aromatic base ($C_6 H_5 \cdot NH_2$), was obtained by dry distillation from Indigo. In 1834 a chemically identical substance was discovered in coal tar and was called Kyanol because of its colouring a chloride of lime-solution violet. The artificial colours which were afterwards produced by oxydising Aniline were originally called aniline colours. In 1856 the English professor W. H. Perkin was the first to isolate a blue colouring matter from aniline and acid of chrome and to demonstrate that it might be fixed on fibres. This discovery was the origin of the aniline colour industry. In 1858 A. W. Hoffmann discovered the common «Rosaniline», and Verguin in the same year discovered the same colour, which he called «Fuchsine». These various inventions did much to stimulate an industry which has afterwards been so enormously developed. Alizarin, one of the finest and fastest colouring matters, is the active colouring matter in the Madder Root. After Grabe and Liebermann and also Perkins had determined its chemical constitution, which is closely akin to that of Aniline, and they had also invented a method for synthetically producing a body of identically the same composition from coal tar, this colour has afterwards been artifically produced and the cultivation of the Madder Root has been discontinued. The cultivation in India of Indigo is still continued, but on a much reduced scale.

The identification of the active colouring agents in the various vegetable colours with inorganic compounds contained in a hitherto almost worthless by-product, the coal tar, and the invention and the constant improvements of synthetic methods by which these valuable colours may be manufactured from this raw material, is indeed one of the greatest triumphs of chemistry in the second half of last century.

The aniline industry was due to the invention of an Englishman and it was first started in England. It was, however, almost immediately transplanted to Germany, and by the continuously sustained and systematic investigations of trained chemists in the labaratories of

the leading German firms the great colour industry has become essentially a German industry. Almost the whole of the aniline colours and 7/8th parts of the alizarine colours which are consumed in the World are produced in Germany.

The firm *Friedr. Bayer* in Elberfeld, established in 1850, was changed into Friedr. Bayer & Co. in 1863, and in 1881 it was converted into a Limited Liability Company under the style of

Farbenfabriken vorm. Friedr. Bayer & Co.

At the beginning the firm traded in natural colours, such as Indigo, Safflor &c. In 1860 it commenced to manufacture artificial colours, particularly Fuchsine. This branch of the business was constantly increased and from 1871 the industrial operations were extended to the manufacture of alizarine and alizarine colours. In the second half of the 80ties pharmaceutical articles (Phenacetin, Sulfonal &c.), derived, like the colours, from coal tar, were also manufactured. After the Alizarinfabrik vorm. Dr. C. Leverkus & Söhne in Leverkusen, near Köln, had been acquired in 1891, it was decided gradually to transfer the whole of the works from Elberfeld to Leverkusen, and since then inorganic raw materials and half-manufactures, such as sulhpuric acid, hydrochloric acid and nitric acid, aniline, salicylic acid, derivatives from naphtalin &c. have been produced at Leverkusen in growing quantities.

The Chairman of the Company, which still has its seat at Elberfeld, is Geheimer Regierungsrat Dr. H. T. v. *Bettinger,* Member of the Herrenhaus. The Managing Directors are Kommerzienrat Friedr. *Bayer,* a son of the founder of the firm, and Geheimer Regierungsrat Professor Dr. C. *Duisberg,* with 5 vice-directors; 18 gentlemen sign per procuration. The share capital of the company is 36 mill. Mk. with 14 3/4 mill. Mk. reserve funds.

WORKS AT LEVERKUSEN.

The firm has works at Elberfeld, Leverkusen a/Rh., Barmen-Ritterhausen, Moscow, Flers, near Roubaix in France and at Albany, N. America.

The sale of the colours and pharmaceutical products of the firm is conducted throgh 27 selling branches and 122 agencies, spread over al the indutsrial countries of the World. In Norway the firm has been represented for about 25 years by Messrs. Keddell & Bommen, Christiania, as their general agents.

The Farbenfabriken produces of coal tar with acids, besides a large number of inorganic and organic raw materials and half-manuactures, about 1 500 different

Aniline-, Azo- and Alizarine-colours and about 60 pharmaceutical products.

In various branches of the colour industry this firm has been the leader, of which it may suffice here to mention the production of the well known Diamond black, the Benzo fast red, the Aleolcolours, the Alizarin-reds and others.

Several of the pharmaceutical products of the firm, such as the antifever medicine Phenacetin, the sleeping medicines Sulfonal, Trional and Veronal and others are well known by the general public, while Aspirin has become immensely popular. All newly invented pharmaceutical substances are carefully investigated, sometimes for years, before being submitted to the doctors. For this purpose the firm has its own pharmaceutical institute. Another product which has spread the name of the Farbenfabriken in all parts of the world is «Somatose», a result of the progress of the therapeutics of the digestion.

During recent years the Farbenfabriken has taken up inventions and the production of photografic preparations and photo-papers.

Quite recently the Farbenfabriken has brought on the market under the name of «Autan» a formaldehyde disinfectant which disinfects houses without the use of any apparatus.

One fine morning I was met at the station Opladen by appointment by the librarian of the library at the Leverkusen works, one of the gentlemen instructed with the duty of taking visitors round the works at Leverkusen.

Imagine a building, very high and some 200 m. long, in the middle a broad passage and on both sides the walls covered, row over row, with big vats. Such is the appearance of the inside of one of the main works; one sees nothing but these big receptacles and the pipes leading from one into the other, except a few workmen who move on the galleries between these vats. In these vats those chemical processes take place for the sake of which this mighty company exists. Often the mixture of the various ingredients produces chemical action which generates so much heat that ice must be automatically added to prevent the temperature from becoming dangerously high; 50 000 tons of ice, manufactured at the ice works, is used annually. At stated intervals small samples of the boiling mixtures are brought by the attendant workmen to the laboratories to be carefully tested by the chemists in charge of the different producing departments, who give the necessary instructions in accordance with the results of the analysis and who also pay frequent visits to superintend personally the development of the processes.

Not only to the layman, but also to the trained chemist the whole is a mystery. To understand anything of the many complicated chemical processes which continually go on in this enormous building one had to be first of all an expert in this particular branch of chemistry, but it would also be necessary that one were allowed to spend weeks or months in close study of the operations in detail.

In an almost equally big building the products were dried and stored.

We visited another large building where the pharmaceutical articles were weighed and packed in apothecary's small bottles and boxes by girls, neatly dressed in white caps and aprons, finally to be packed in cases ready for shipment.

At the far end of the immense ground near the river Rhine are the sulphuric acid, hydrochloric acid, nitric acid and soda works; we did not go into these, but I was told that they were very large; the sulphuric acid works was bigger, I was told, than any similar works in the world.

In the works there are

140	steam boilers	aggregating	12 759.5 m.² heating surface
192	steam enginess	—	12 434 hp.
463	electro motors	—	6 851 »

The ground at Leverkusen has an extent of 381 ha. or about 950 acres. The works are connected with Mülheim a/Rh. by a private normal guage railway 7 km. long. Within the grounds there is a narrow guage railway 33 km. long which is worked by 1 accumulator electric engine and 10 steam engines.

The firm has its own waterworks with a daily capacity of 60 000 m.³ (for the sake of comparison it may be mentioned that the combined towns Elberfeld—Barmen with a population about 500 000 use about 55 000 m.³ per day).

The firm has at Leverkusen a printing and bookbinding works (employing more than 100 people), a saw mill, joinery works, a cooperage works, boiler works and a number of large and small engineering works.

We visited several of these subsidiary factories; in the bookbinding department a large number of girls were employed in preparing showcards with small samples of dyed thread, and in so doing they were singing part songs learnt in their singing association.

My guide explained that each of the many departments was treated as an independent concern, buying of and selling to the others; the central power station, for instance, bought coals and sold power to the various works using it.

At its different works and offices the firm employs 1519 officials of whom 203 are chemists, 8 doctors, 3 lawyers, 1 philólogist (the librarian), 45 engineers, 79 building engineers and architects, 281 other technical officials and 899 commercial officials and office assistants.

The chemists belong to two categories: those who are attached to the works, and those who do scientific, research work. They not only receive good salaries, but if a chemist makes a discovery, either an entirely new article or an improvement, he receives in addition to his salary a bonus upon the results of his invention.

We visited one of the laboratories; each chemist had a department all to himself, equipped with the very best apparatuses; the University chemists who visit us, always envy our laboratory installations, they said. But that is not all. In 1897 the firm took

over the library of August Kekulé and the reference library of Viktor Meyer and their chemical library was thereby increased to about 14 500 volumes and about 30 000 pamphlets and separate prints, so that it is probably the most valuable collection of its kind in existence. In connection with this library which is still at Elberfeld there is a reading room in which 360 periodicals, dealing with chemistry and kindred topics, are available for the officials. An intelligence office keeps all the branches rapidly informed of those news in these periodicals which may be of importance for them.

In this manner the operations of the firm are based upon constant, never remitting, systematic investigation by an army of the most highly trained scientific experts. Invention is, as it were, organised as a distinct department and is liberally rewarded and the daily routine of the business is carried on with the utmost exactitude by men who know and understand absolutely all the processes; nothing is left to chance.

KAISERPLATZ IN WIESDORF.

The enormous and constant growth which the Farbenfabriken vorm. Friedr. Bayer & Co. have on record, abundantly prove the soundness of their policy.

They employed

at the end of	1875	119	workpeople
—»—	1880	298	—
—»—	1885	555	—
—»—	1890	1 264	—
—»—	1895	2 506	—
—»—	1900	4 515	—
—»—	1905	5 658	—
at the end of	1906	5 875	workpeople
—»—	1907	6 050	—
—»—	1908	5 612	—
—»—	1909	5 403	—
—»—	1910	6 625	—

As there were in 1907 also 1519 officials the works had at the end of that year altogether about 7 600 employees.

The directors and proprietors of this great undertaking have always been very anxious for the well-being of their employees, and before we visited the works I had an opportunity of studying the «Wohlfartseinrichtungen» or the institutions for the good of the employees, which my guide explained as we went along.

At Leverkusen a large number (about 300) workmen's houses have been built. Each house contains 4 dwellings with separate entrances and a garden plot for each family. And each year 20 new similar houses are added to the colony. The dwellings are let at moderate rents to the workmen. In two well arranged bachelor's buildings the unmarried men may live for 20 to 35 Pf. pr. day; they may also have board for 85 or 95 Pf. pr. day. These two houses have about 400 inhabitants. There are prizes for the best kept workmens' houses and gardens.

In the Officials' and Workmens Savings Bank the savings receive an interest of 5 % and in addition saving is encouraged by prizes.

Those workpeople who live away

from the works may have a substantial dinner at the eating house for 33 Pf.

In each department of the works there are bath rooms and on the Rhine there are swimming baths.

The company pays in addition to the sick money prescribed by law a voluntary addition of 50 % and the workmen and their dependents have free doctor and hospital treatment. There is a special institution at Leverkusen for the treatment of affections of the lungs.

In the lying-in-hospital the wives of the workmen are received gratis during their confinement, and free help to keep the housework going in the meantime is also given.

annually for an autumn jubilee festival for those labourers and members of the staff who can each year celebrate their jubilee in the services of the firm, and further he gave donations amounting to M. 70 000 to other purposes in connection with the «Wohlfarts»institutions of the firm.

As widows of the officials do not receive any support or at least not sufficient from the pension funds Frau Hermann *König* has given a donation in rememberance of her late husband for this purpose.

On all these donations the firm pays 5 % interest.

In addition to Jubilee prizes the employees receive service prizes after 25, 40 and 50 year's service, rising

THE RECREATION BUILDINGS.

A home for girls offers the same facilities as the bachelor's homes, and in connection therewith there is a school for household work in which the daughters of the employees are taught household work during one year's courses while they are also fed and clothed.

The former Director Herr Geheimer Regierungsrat Dr. v. *Bøttinger* has given a donation of Mk. 60 000 for sending children of the workmen who are in need of it to sanitoriums.

Herr Kommerzienrat Friedr. *Bayer* has given a donation for sending away for convalescence wives and children of workmen and another of Mk. 40 000 to do the same for the wives and children of officials who can not afford it.

The managing director Herr Geheimer Regierungsrat Dr. C. *Duisberg* gave on the occasion of his 25 year's jubilee a present of 3 Mk. to all their labourers (representing of gift of M. 18 000) M. 25 000 to sundry associations of which fund the interest is to be used

from 25 Mk. on 25 year's service to Mk. 1085 on 40 and Mk. 4055 after 50 years service.

The works have further a fund which at present reaches nearly 2 mill. Mk. and which is annually increased with from Mk. 100 000 to Mk. 400 000 out of the profits of the company. On the capital of this fund the firm pays 5 % interest. It is managed by a committee of workmen and the revenues serve to support or pension sick or invalid workers and the widows and children of workmen.

I received a book which contained all this information before we had arrived at the

Erholungshaus

or the recreation buildings. This has been erected at a cost of Mk. 400 000 and is a club house for both officials and workpeople belonging to the works.

It contains a hall for festivals which can seat more than 1 200 persons, where festivals are held,

lectures and theatricals are given. It was opened in 1908. Besides a restaurant where no spirits, only beer, is sold, there is a fine reading room with a reference library and a large number of newspapers and periodicals, 2 halls for association meetings and 4 skittle alleys. The firm has instituted a fund for the support of all its Wohlfartseinrichtungen, which amounts at the present to Mk. 100 000.

There are at Leverkusen workshops for apprentices and a secondary school for the sons of the employees. There is also a lending library with about 13 000 books of which a doctor of philosophy is the librarian. With pardonable pride he told me, that in 1909 not less than 83 023 volumes that been lent.

On our way after having inspected the household school we looked into the fine park and I was told of all the singing, gymnastic and other associations, which have been formed among the employees, of the concerts, lectures, of the instruction in gardening, handicraft work &c. which is given; my guide showed me the doctor's quarters with operating theaters &c., gave me a peep into his own office and the library which had already outgrown its rooms and we finished with an excellent breakfast in the casino of the officials.

The hours of work in the different factories are from half past seven to 6 o'clock with 1 1/2 hours rest for meals, making a working day of 9 hours.

If it is not easy, or indeed possible, for a stranger to understand the complicated chemical processes which take place in these large works, but one carries away from a visit to Leverkusen a deep and lasting impression of a business conducted on scientific and enlightened principles, and the most profound admiration for the wise policy which has created these grand institutions for the good of the vast community of these works, all of which institutions are managed by joint committees of officials and workpeople.

KRAHNEN & GOBBERS LIMITED,
SILK MANUFACTURERS.

KREFELD

Through the large Krefeld factory of this firm I was accompanied by Herr August Hilger, who told me that it was established in the year 1856, at first only in a small way and for handlooms. The first steam engine was not acquired before 1882; but since that time the business has been rapidly developed, and the firm which has been converted into a Limited Liability Company has now 3 factories, the one I visited in Krefeld and two in Wassenberg. It employs about 1100 labourers and has about 1200 looms.

The buildings which are very large have 5 stories. All the rooms were kept most scrupulously clean and as they are substantially built and splendidly lighted, a visitor receives a most favourable impression.

In the bright drawing atelier a number of artists are constantly employed in making new designs, which are first drawn as beautiful pictures and subsequently transposed on square-lined drawing paper, preparatory to cutting the Jacquard cards for the loom.

Some of the many effects which one admires in the finished silk goods are obtained by printing variegated figures on the outstretched Kette or warp. When this is done it gives the woven cloth a very pleasing scintillating appearance.

Some of the cloths are also printed in colours just as calico printing on cotton cloth. Altogether a tour through the many departments was highly interesting to me who had not previously seen a silk weaving establishment, but the most fascinating part was the beautiful large weaving shed, where there were no less than 600 looms; on an average each labourer tended two looms. I should not have had any objection to staying there the whole day, going from one loom to another and admiring how the various designs were gradually formed; it was, for instance, highly interesting to observe how «effect» yarn was introduced here and there in the designs by tiny little shuttles outside of the weaving frame proper, running at given intervals in between and round certain of the warp threads. But, unfortunately, my time did not allow me to stay very long as I had also to go to other factories in the same town.

The main branches of the production of the firm are:

neck tie silks,
lining silks, silks for dresses and blouses,
ribbons.

In Germany the firm is represented by agents in nearly every town of any importance. They also do a very large export trade, having their own office at 2 & 4 Carey Lane, Cheapside in London.

Their agent for Norway is Mr. Otto Døderlein in Christiania.

DEUTSCHE MASCHINENFABRIK A/G

DUISBURG

In the second half of 1910 his firm was formed by the amalgamation of the following three firms

Duisburger Maschinenbau A/G
vorm Bechem & Keetman
Duisburg,

Benrather Maschinenfabrik Actiengesellschaft
Benrath,

Märkische Maschinenbauanstalt
Ludwig Stuckenholz A/G
Wetter a/d Ruhr.

At the time of my visit, in the spring of the same year, they were «in einer Interessengemeinschaft mit einander verbunden» viz: allied in a community of interests.

The *Ruhr* valley is by far the most important coal mining district of Germany and during the last 40 years it has also become the greatest German centre of the iron and steel industry. This industrial evolution, which for rapidity is probably without a parallel, has of course created a rapidly growing demand for machinery.

The conditions under which the staple trades of the district — coal mining, iron and steel making — are carried on, made it an imperative necessity that the machinery used in these trades, and, particularly, that the appliances for loading and unloading of coals and iron ore, should be constantly and rapidly improved. This has been a necessity because the coals must be sent by rail down to the Rhine and transferred to Kähne or barges and the iron ore arriving at the Dutch sea ports must first be sent up-stream to Duisburg—Ruhrort in barges and thence by rail to the iron works. And as the iron and steel production has grown so rapidly that the produce can only be disposed of in the markets of the World, the Westfalian iron trade had to make itself absolutely «konkurrenzfähig» in order to meet the foreign competition.

These circumstances created a keen demand for able and progressive manufacturers of machinery. And the local requirement for improved mechanical appliances for loading and unloading of coals and iron ore and also for handling, in the engineering and steel works, very heavy pieces of steel and machinery, has caused some of the local engineering works to specialize in this particular branch of engineering to such an extent, that they have thereby become able to compete successfully in the markets of the world in loading appliances and cranes of various types. They have become in a short time World firms, instead of being only locally employed and relatively small concerns.

My first visit was to

Märkische Maschinenbauanstalt Ludwig Stuckenholz A/G, Wetter a/d Ruhr.

This little town has only recently been raised to the rank of a «Stadt» which event has been celebrated by the erection of a fine stone-built Rathaus overlooking the pleasant Ruhr valley.

The Stuckenholz works is situated close by the railway station.

The engineer who received me explained that the three firms had formed an alliance because they could thereby distribute the orders between themselves more advantageously than when working separately.

Cranes and shipbuilding berths (Hellingausrüstungen) were mostly manufactured by Messrs Bechem & Keetman at Duisburg. In Wetter Messrs Stuckenholz manufactured cranes and machinery for mines, for instance winding and hauling machines driven by steam or electricity, machinery for and the entire planning of blast furnaces and steel rolling mills, heavy steam engines for mines and rolling mills and finally all kinds of steel structural work and accessories.

Both firms supplied loading bridges for loading or discharging coals, iron ore or other kinds of merchandise.

At Duisburg rock boring machinery was also manufactured on a large scale and there was a large production of chains and anchors for the home trade and export.

The Benrather Maschinenfabrik at Benrath near Düsseldorf had discontinued its office and drawing departments, executing orders which were sent from either Duisburg or Wetter.

Such was in the main outlines the division of labour between these works which have afterwards become amalgamated into one wpoerful firm.

Märkische Maschinenbauanstalt was established 1819 and is thus one of the oldest machinery firms in Germany. *Ludwig Stuckenholz* established engineering works at Wetter in the year 1830. He constructed for use in his own workshop a travelling crane which led to his taking up later on the construction of cranes as a speciality.

It is only quite recently, in the late 70'ties, that travelling cranes have been introduced in Germany, and before their introduction the iron works could not supply ingots or plates of more than relatively small weights, in fact, not larger pieces than that they might be handled by manual labour. And electrical transporting plant is of still newer date. It was not before 1898—1899 that the building of such was commenced, because the electrical firms could not before that time supply suitable motors.

In the Summer of 1906 Märkische Maschinenbauanstalt and Ludwig Stuckenholz were amalgamated.

Duisburger Maschinenfabrik A/G vorm. Bechem & Keetman in Duisburg was established by Messrs Bechem & Keetman in 1863 as an engineering works in a small way. Both the founders are dead, but Mr. Wilhelm Ernst *Keetman*, a son of the founder, was at the time of my visit still the principal shareholder and took a leading part in the management of the firm.

Benrather Maschinenfabrik A/G Benrath near Düsseldorf, was established in the year 1896.

These three firms who were engaged more or less in the same branches of the engineering trades and competed sharply with each other, entered in the beginning of 1909 into an agreement to work hand in hand, and in July 1910 they were completely amalgamated into

ERECTING SHOP DUISBURG, 25 M. HIGH.

Deutsche Maschinenfabrik A/G
Duisburg.

The share capital is Mk. 10 500 000. The managing directors are Messrs *Kauermann* and *Reuter*. In addition there are 20 «Procuristen» or gentlemen who sign per procuration.

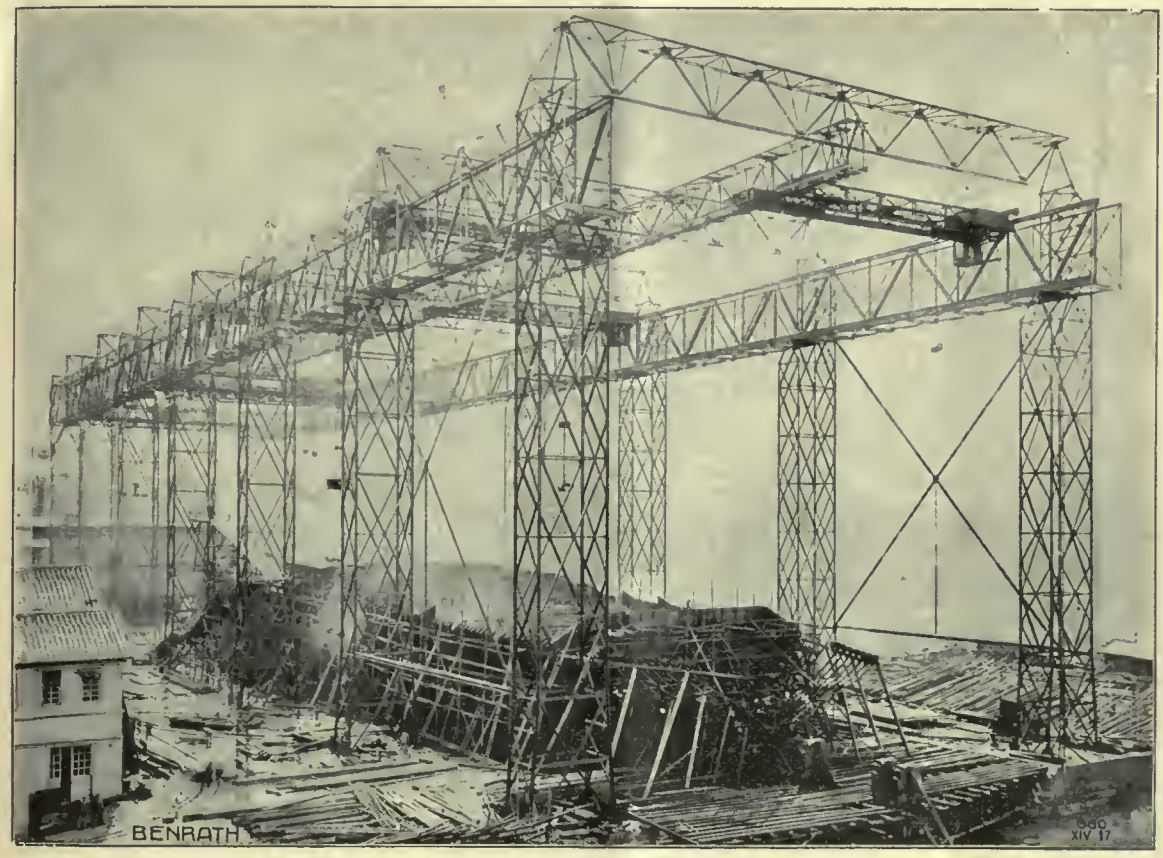
The three firms at Duisburg, Wetter and Benrath, had each made a special study of the construction and production of cranes of every variety of type; the amalgamated firm is without any doubt the first crane makers in the World. This is proved by the very large number of cranes of all kinds which these firms have supplied to countries all over the world. It is quite characteristic that several big British shipbuilding firms who would, of course, prefer to support home makers, have taken their mammoth cranes from Germany, that is to say, from these three firms. I give some pictures and particulars of cranes recently sold abroad.

The Deutsche Maschinenfabrik A/G is further able to supply complete installations for blast furnaces and complete iron and steel works fitted with all machinery and even the buildings and the entire planning of such works with the exception of the electrical installations.

They are also prepared to plan and make complete arrangements for shipbuilding yards, including what is called in German Helling-Gerüst or crane arrangements for shipbuilding berths. They have supplied such to nearly all the German shipbuilding yards and also to foreign countries, for instance several to Japan. As this ought to be of interest to Norwegian shipbuilders, I give some illustrations and particulars.

At the works in Wetter there are employed about 1150 workmen and an office staff of 390, in Duisburg 1400 men and 500 officials, at Benrath 1000 men and 50 officials — in all about 3500 workmen and 940 officials. This is an unusual number of engineers in proportion to the number of workmen, being more than one to four.

The works are well arranged, as might be expected, and they are supplied to a quite exceptional extent with travelling cranes and other modern appliances for handling mechanically very heavy pieces of machinery. If this had not been the case and if the machine tools had not been of a powerful nature a very much larger number of workmen would have been required. Indeed, if these appliances had not been, it would have been impossible to handle such heavy pieces of machinery as I saw.



SHIPS BERTH CRANE.

But in the main this very large percentage of draftsmen to the number of mechanics is due to the nature of the work which is undertaken. The firm is not only occupied in the heaviest branches of the engineering trade, but they undertake to plan complete schemes for mines, blast furnaces, iron and steel works, loading arrangements, mammoth cranes and travelling cranes &c. &c. And as these schemes have to be adjusted to the special circumstances in each case, new calculations and new designs have to be prepared

almost for every new order. I was told that frequently 5 or 6 draftsmen were employed during 5 or 6 months to prepare sketch schemes for one of the big ship-building cranes as a preparation for negotiating for the contract. After the order was secured, and before the execution could be commenced, as many as 250 drawings had to be made for the mechanical arrangements and 80 for the castings, and altogether between 400 and 450 drawings had to be made. So one can understand that a big staff of clever engineers is required. But because the firm has reached such a high position in its special branches of the trade and can afford to keep these numerous staffs, it can not only organise them in different departments of expert specialists, who thus gain a vast experience, but the firm is also in a position to undertake large contracts within a much shorter time of delivery than most of its competitors, which is again one of the secrets of its success.

This specialisation of the engineering and drafts departments is also conducive to inventions and improvements being made. I was shown an interesting example of this. In America a magnetic crane was recently invented, but the practical results were not so good as anticipated. This invention has, however, been developed by Merss Stuckenholz in Wetter and I give a picture showing a magnetic crane as now produced by the firm.

The following day I went to Duisburg where I was received by appointment by Herr *Kauermann*, the managing director of Messrs Bechem & Keetmann, at their head office in Werthauer Strasze. As Herr Kauermann had to go on a visit to Benrath he deputed Herr Fritz Kalthoff, chief engineer of the drawing office for steel structural works, to show me the works and give me the information which I required. As Herr Kalthoff has special charge of the firm's Norwegian business, we had, as it turned out, many mutual friends and many topics on which we were both interested.

BIG TRAVELLING CRANE.

As I have already sketched the special features of the trade of the firm, I need not here repeat this. But I wish I were capable of giving a word picture of the manner in which this firm has been, within the last few years, under the inspiring leadership of Director Kauermann, completely remodelling their works. The old works are situated at Mülheimer Strasse in a part of the town which is becoming one of the finest residential quarters. Some twenty years ago land was acquired in Werthauerstrasse close by the harbour where a small branch office was established for the crane trade.

After a large additional plot of ground on the other side of the railway line had been acquired it was decided to remove gradually the entire works to

this place and to construct entirely new, in every respect up-to-date, works on the new land and to completely re-arrange the old works; when these alterations are completed the works at Mülheimerstrasse will be sold for building purposes. A very substantial building 64 m. long and with a total area of all storeys of 10156 sq.m. for commercial and enginering offices was completed in 1909 and enlarged in the spring 1911.

In accordance with the scheme at first decided upon a travelling crane had been erected at a considerable expense, but on further consideration another scheme for utilizing the site was preferred, as it was found that it possessed considerable advantages over the original plan. But this change of the plans involved the necessity of taking down again the said crane arrangement. I mention this, to show how everything has been subordinated to the one aim of getting the best and most convenient works.

The site has the form of a regular parallelogram. The salient feature in the scheme for utilising the same is, that there is only one line of railway with two tracks running at the long side of the parallelogram, while the immense erecting shop, the engineering shop, the store rooms etc are built perpendicularly on the railway line and all of them as well as the open store yards between these buildings are fitted with travelling cranes which run over the railway lines.

I give a picture of the erecting shop, which is 25 m. high and beautifully lighted. At a height of 11.5 m. is mounted a 50 ton travelling crane, and 6.5 m. above this is another rapidly moving crane for 10 tons which can thus move lighter weights over the lower, heavier crane. All foundry work is executed at Wetter; I saw cast pieces weighing upwards of 30 tons. At the time of my visit the big erecting shop was almost completely filled by a number of loading cranes for Aktieselskabet Sydvaranger, Christiania and Sydvaranger, Norway, which were just being got ready for shipment. The structural parts of the buildings that were to receive these cranes were being executed after the designs of the firm by Messrs *Vulcan* in Christiania.

CRANE WITH LIFTING MAGNET.

It is needless to say that in this erecting shop — which has in one end a deep well, so that machines of a height of not less than 25 m. may be mounted — as in all other parts of the works the machine tools are of a very powerful and of the most modern character. The machine tools are almost without exception made by German firms. The days when we were obliged to go to America for tools are past, remarked Herr Kalthoff. In the engineering shop the smaller tools were arranged in a row in the middle and were worked electrically in groups, while the heavier tools placed alongside the walls had each their separate motor.

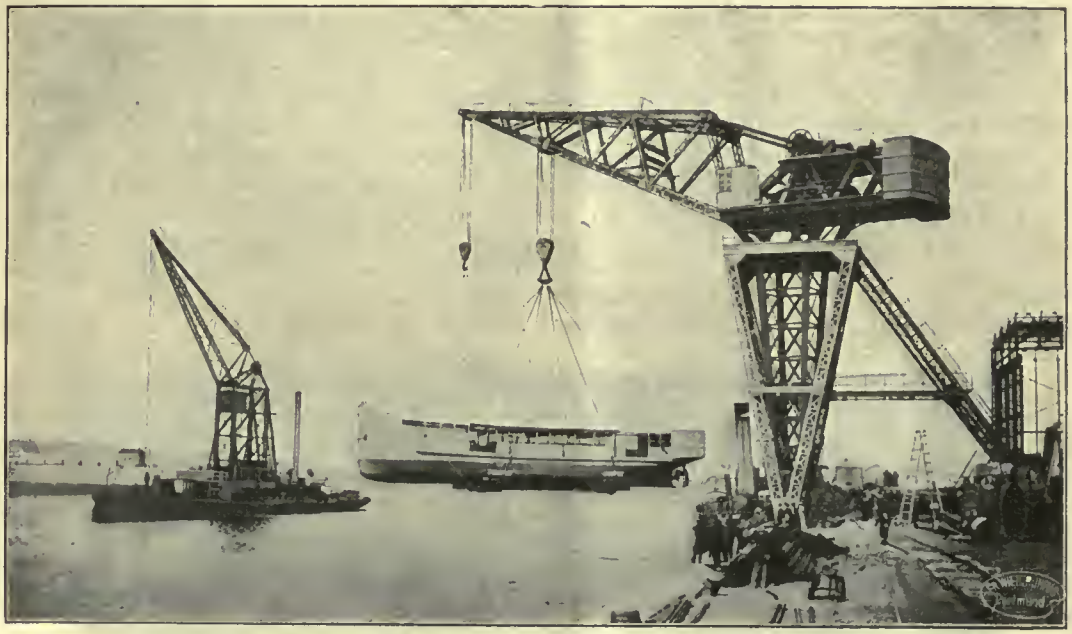
By way of an ingeniously constructed bridge over the public railway access is gained to the old works, where rebuilding was going on on a vast scale. It was

SHIPPING CRANE WITH MOVABLE CRANE.

to me particularly interesting to observe that the old parts which were not more than twenty years old represented the same type of more or less inconvenient arrangements and badly lighted rooms with which I am so well familiar from older Norwegian engineering works. And on my question Herr Kalthoff replied that it is not more than 10 or 15 years ago that one commenced here in Germany to adopt the modern and, as I would call it, scientific way of arranging works buildings and utilising the ground. The changes which are being made are very thorough, but costly and take long time, which interferes considerably with the daily operations.

Having inspected this structural work we went upstairs to the department for rock boring machinery. Here everything is specially adopted for a standardized wholesale production. Herr Kalthoff told me that in the relatively small rooms of this department they could turn out machinery for 1 1/2 Mill. Mk. annually. They had just secured, after severe competition, very large orders for the Rand mines in Transvaal.

The chain and anchor manufactory of the firm which was still at Mülheimer Strasse, I had not time to visit. I was, however, informed that they did a very large trade both for the home market and for export.



«PHOENIX» AKTIENGESELLSCHAFT FÜR BERGBAU UND HÜTTENBETRIEB ABTLG. DÜSSELDORFER RÖHREN- UND EISEN-WALZWERKE (VORM. POENSGEN)

DÜSSELDORF

Herr Kommerzienrat C. R. *Poensgen*, the managing director of this company, is also the chairman of the Düsseldorf Chamber of Commerce. Through Dr. *Treschcr*, scientific assistant to the Chamber, he had let me know that I would be permitted to see their works. When I presented myself at the office, the Kommerzienrat received me most cordially, asking me about mutual friends in Norway. We had a long conversation about the industries of this district, their rapid progress and present condition. Recent legislation and taxation, he told me, pressed very heavily upon trade and industries, and he recommended me to study the introduction to the last annual report of the Chamber of Commerce. The reader will find a translation of this introduction on page 19 of the present number.

His firm, established in the year 1848 and formed into a Limited Company in 1872, was the pioneer of the tube industry in Germany. At the time when their works was established they bought what was then considered as a large tract of land outside of Düsseldorf. The business has grown so much that all available space has been used. And the neighbourhood which has grown, largely as the result of the operations of this firm, into one of the most populous quarters of Düsseldorf has long ago become a part of the city which has outgrown in this as in all directions its old narrow boundaries.

An engineer was told off to conduct me over the works. We first visited the rolling mills, where there are two mills for rolling strips which are either used for making tubes or sold, and one mill for rolling soft steel to wire. In order to explain the wire making process I borrow a picture of a wire rolling mill from the catalogue of the Benrather Maschinenfabrik. The white hot rods coming from the rolling mill at the back are placed by the workmen between the first pair of rollers at the left of the picture; they are thereupon placed automatically by the bent rails at the back into the second pair of rollers. The machine working at a rapid speed the rods come out as a hissing and twisting deadly pair of serpents, and it requires great nerve and a swift hand to grip them by a thong in order to put them into the claw of the third pair of rollers where the same operation is repeated. As each pair of rollers has a smaller opening than the previous one the wire is thus drawn out, becoming longer and longer

WIRE ROLLING MILL.

as may be seen on the picture, and when it has passed through the whole of the machine it comes out in the requiered diameter and is automatically rolled up in bundles which are at the same time weighed. The firm produces wire ranging from 5 mm. to 12 mm. diameter.

In the tube works the strips which I had seen being rolled, are first bent round in one machine, and having been heated in a furnace to red heat, the half manufactured tubes are rolled throug a succession of smaller and smaller dies over a punch. Thereby not only is the tube reduced to the desired diameter, but the edges of the metal are so strongly and firmly welded together that it was only with the greatest difficulty I chould discover where the welding had been done. By this process tubes of from 12 1/2 inch. to 4 1/2 inch. diameter are manufactured. They are straightened and tested by water pressure to see if they are tight. A large assortment of tubes is always kept in stock. By another process tubes of still smaller diameter are manufactured.

There are engineering shops for fitting the tubes with screwing and sockets and otherwise finishing them and also shops for bending tubes to any desired shape for boilers, for cooling apparatuses &c. and any other purpose where high pressure tubes may be required. I saw big tubings being manufactured for a blast furnace, and many other orders of different sizes and shapes were in course of construction.

At their Siemens-Martin steel works at Düsseldorf-Lierenfeld the firm produces soft steel for their rolling mill and for sale and they also manufacture a great variety of other articles, such as boiler plates, ship plates, boiler ends, universal bars and stampings for any purposes.

Gas tubes, weldless tubes, pressed steel barrels and pyramids of tubes of the most varied shapes were used by the firm to construct their very effective exhibit at the Düsseldorf Industrial Exhibition in 1902.

The firm which does a large export trade, employs at their two works 2700 labourers and 250 officials.

Since my visit the firm Düsseldorfer Röhren- und Eisen-Walzwerk has been amalgamated with «Phoenix» Aktien-Gesellschaft für Bergbau und Hüttenbetrieb.

GUTEHOFFNUNGSHÜTTE

AKTIENVEREIN FÜR BERGBAU UND HÜTTENBETRIEB, OBERHAUSEN, RHEINLAND

On April 5th 1910 the following article appeared in the *Kölnische Zeitung:*

»Today the great industrial concern the *Gutehoffnungshütte* could celebrate the centenary of its establishment.

On April 5th 1810 Gottlob Julius Jacobi of Sterkrade, the brothers Gerhard and Franz Haniel of Ruhrort and Heinrich Huyssen of Essen signed the contract for the Hüttengewerkschaft and trading firm Jacobi, Haniel & Huyssen with its seat at Sterkrade. This undertaking was entered in the register of firms, in 1862, under the style of Jacobi, Haniel & Huyssen and converted in 1873 into

Gutehoffnungshütte
Aktienverein für Bergbau und Hüttenbetrieb,

the seat of which was removed in 1875 to Oberhausen, Rheinland.

The varying forms of the undertaking have not changed its internal constitution, for to this day the shares of the company are held, with quite insignificant exceptions, by the descendants of the original four founders. It has thus been possible to retain for the Gutehoffnungshütte during three generations the character of a family concern, a fact which has always determined the evolution of the business, the spirit of the management and the financial history, and, no doubt, in a beneficial manner.

The object of the concern, when founded, was to acquire and carry on three Hütten or blast furnaces which were situated in the neighbourhood of Sterkrade, viz. the St. Antony Hütte, established 1757, the Gutehoffnungshütte, established 1781 and the Hütte Neu-Essen, established 1791. These blast furnaces, together with the St. Michelhütte at Neu-Essen Baholt and the Isselburgerhütte mark the beginning of the iron industry on the right bank of the Rhine, which district, within and below Duisburg, has become after 1850 such a powerful centre of the German Iron and Steel industry, and the history of these blast furnaces is also in the main the history of the whole of the Lower Rhine—Westfalian iron industry between 1810 and 1910. But the history of the Gutehoffnungshütte is particularly interesting because it is the only iron, steel and rolling mill company on the Lower Rhine with iron-ore and coal mines, with finishing works of various kinds such as shipbuilding yards and engineering works, which may look back upon an unbroken evolution from a small charcoal blast furnace as the origin. All those questions in connection with this industry which are of practical interest to the engineer, the political economist, the statesman and the politician have had to be solved. A mixed works has been evolved and not created as an imitation of similar undertakings by the help of large external capital, but as a natural growth by the gradual grafting of the most heterogenous industrial undertakings on to the small initial business. In 1810 the business was restricted to a few blast furnaces and iron foundries; in 1812 the freshing and hammer processes were commenced. But for this purpose pig iron from the middle Rhine and Lahn districts was required. In 1835 the puddling process, entirely depending upon foreign, mostly English and Belgian, pig iron was started. To the puddling activity was added the first rolling mills for rails, rods and plates. In 1844 a protective duty was placed upon imported pig iron and manufactured iron and at the same time one had learnt to convert Ruhr-coals into coke, suitable for blast iron furnaces, and thereupon the production of the necessary pig iron for the puddling works was undertaken. And in such manner the mixed iron works was evolved which carries on iron ore and coal mines on the one side, steel works, rolling mills and finishing iron works on the other.

At first only «Rasenerz» or bog iron ore from the neighbourhood between Ruhr and Lippe was employed. But this supply became insuffient already in the 30ties, Borings in the Lower Rhine district for iron ore were fruitless, and it became necessary to go further afield and to obtain ore from the Lahn and the Middle Rhine districts. After the new large blast furnaces for the use of coke were started in 1855 with a greatly increased ore consumption in comparison with the time of the small charcoal furnaces the difficulty of obtaining ore increased. But succesful efforts were made for keeping the undertaking independent of the ore market, by opening the Lower Rhine coal and iron fields, by acquiring Rasenerz or iron ore deposits in Belgium

and by increasing the output from the Middle Rhine iron ore mines. The firm fairly maintained its independence until 1872, relying upon the above mentioned ore deposits. But from that time there was a rapid change. The consumption of ore constantly increased while the ore sources gradually dried up. In 1890 only 25 % of the ore consumption was produced in the mines of the firm, but after the Minette deposits in Lothringen were opened in 1896 this percentage has again become better.

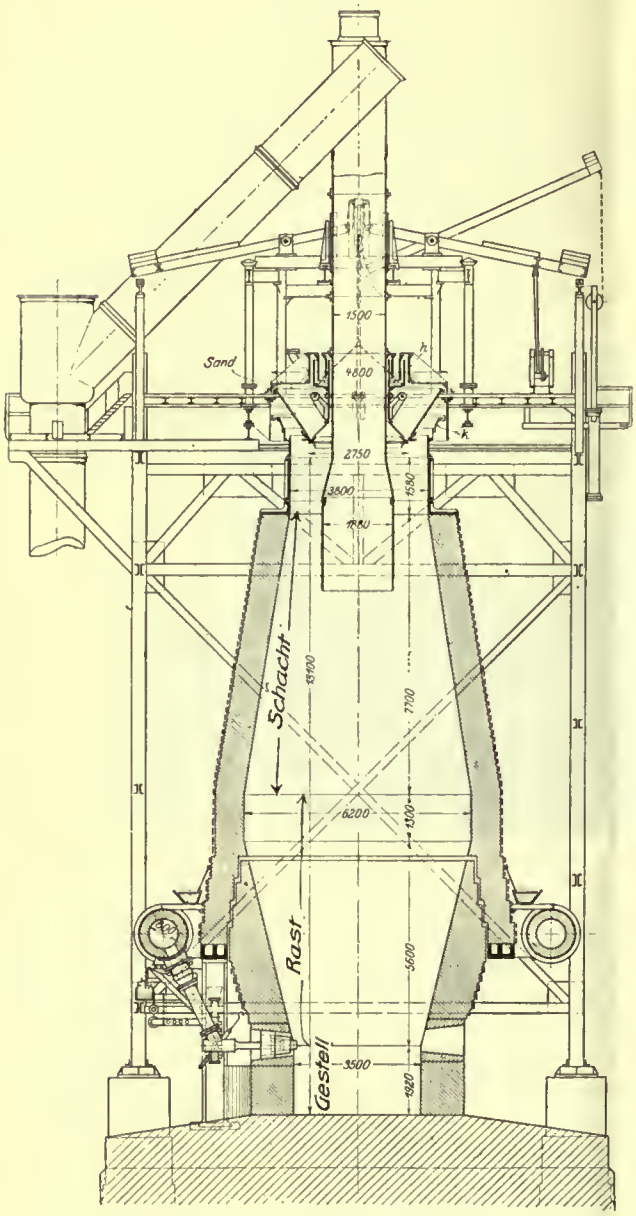
As was generally the case in Rhineland and Westfalen, coal mining and iron industry were for a long time carried on by the Gutehoffnungshütte independently of each other. Until 1855 all the coals that were used were purchased, although the consumption of coals had already at that time reached 40 000 tons, and at that time already complaints were frequent as to the price policy of the coal mines in rising markets, of the difficulty of obtaining the right sorts of coal for industrial purposes, of lack of railway trucks, and of the heavy freight charges from outlying coal mines. But the large coal requirements, due to the starting in 1855 of the coke blast furnaces, caused the management to acquire their own coal mines at Oberhausen. In the relation between the coal output of the firm and their own coal consumption one may distinguish between three epochs. Until 1872 the requirements of heating material for the blast furnaces were mainly covered by purchases in the market. But from 1858 there was a gradual increase in the coal production of the firm so that in 1872 one half of the comsumption was covered by their own production and only one half purchased. But coals were only sold in so far as the coals from their mines were not suitable for use in their own works. Between 1872 and 1904 this relation has been reversed. For to a growing extent the blast furnaces were supplied with coals of their own output, the purchases became gradually less important while the sale of coals has increased nearly twenty times. The mines are therefore not any longer worked with a view mainly to supply their own needs, but also for selling purposes. And after 1905 the purchase of coals ceases altogether. The firm itself consumes 1 538 000 tons of coals, but the sales amount to pretty nearly the same quantity, reaching 1 466 000 tons. Since the coal mines have developed to such a point the fortunes of the Gutehoffnungshütte have come to be largely dependent upon the results of the coal mining operations.

The salient point in the financial policy of the Gutehoffnungshütte is that the firm has never employed outside capital; this fact has always secured for the Hütte a great independence, but on the other hand it has also compelled the management to a prudent limitation in regard to extensions. If the financial situation of the Hütte has been during the last years an easy one, this is the result of great sacrifices and losses in the past. The owners of the Hütte have twice decided to reduce the dividend distributions. Between 1855 and 1872 the dividend was fixed at a maximum of 4 %, and between 1879 and 1898 of 5, respectively 4 %, and during almost a decennium from 1880 to 1890 it was not even possible to reach so much, and meanwhile the share capital of the Hütte had been written down in 1878 from 30 mill. to 6 (viz. six) million Mk., an exceptionally drastic step which has probably not many parallels.

NEW BLAST FURNACES.

There are three families who have during the past century been closely allied with the Hütte. First of all the family Haniel of whom two members were among the founders of the concern. A great number of members of this family have since 1810 taken part in the management of the Hütte. But the family Jacobi must also be mentioned as it produced the first technical manager of the undertaking, Gottlob Julius Jacobi, who was highly esteemed by his colleagues and by the customers. And, finally, the family Lueg has won for itself an honourable place in the history of the Hütte through Wilhelm and Karl Lueg.»

By the kind permission of the directors I was allowed to visit the blast furnaces and steel works of this famous firm at Oberhausen. As it was the first time I have seen a modern iron works, it naturally interested me very much; and as probably many of my readers have never been in an iron works, I will try to give a description.



BLAST FURNACE FROM 1899.

The company employing altogether about 25 000 officials and workmen, the general offices are, one may imagine, very large.

We first inspected the ore storage yard. The bulk of the ore is obtained from Luxemburg and Lothringen (so called Minette); part is also of German origin. Ore is imported from Spain, Russia and Greece and large quantities come from Sweden (Grängesberg —Gellivara and Kiirunavaara). The ore is shipped from the North Sea ports in lighters on the Rhine to the Company's own port Walsum. From there the ore is transported on a private railway to the large storage yards at the blast furnaces.

There is a great variety of iron ores, differing both in their chemical composition and in appearance. For each kind there were separate sheds or «pockets» into which the ore was emptied from the railway waggons running above the sheds. A system of endless wire rope transporters runs between these storing sheds and the different blast furnaces.

Next we visited the Engine room where are 10 gasmotors of 1000 hp. each, all manufactured at the company's own engineering works at Sterkrade. These engines which are driven by the gases that are formed in the blast furnaces, are used for producing the air current (the blast) which, being pressed into the furnaces, yields the oxygen which is required for reducing or smelting the metal. Ey one stroke of the piston the air is drawn into the cylinder from the outside, by the counter stroke this air is compressed and forced into the air pipes leading to the furnaces.

Our next move was to the newest of the 11 blast furnaces.

A Hochofen or high blast furnace consists of 3 parts:

1) a cylinder at the bottom, called the «Gestell» which may vary in different furnaces between 2 and 4,5 meter in diameter and 2 to 3.5 meter in hight. Here the wind or blast pipes open. This part of the furnace serves as collecting basin for the molten metal and the slags.

2) a conus called the «Rast» which widens upwards to 6 to 7 meter.

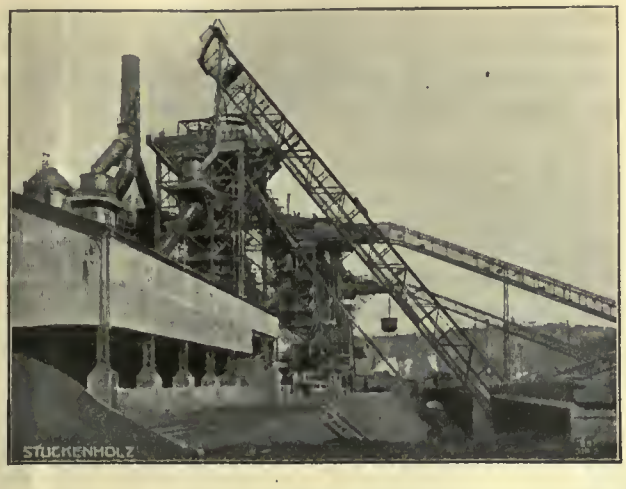
3) and on the top of this another conus the «Schacht» which narrows at the top or «Gicht».

The part where Rast and Schacht meet is called the «Kohlensack» (the coal bag). The funnel shaped opening of the Schachtris called the «Gicht».

The inside walls ae lined with fireproof bricks; to prevent them from being too rapidly worn by the heat and the chemical action of the slags they are constantly cooled by running water, 2 to 3 m.^{3} of water being used per minute on a modern furnace.

For the smelting of the ore and to get a metal slag of suitable composition it is necessary to add to the ore a larger or smaller quantity of limestone. It is, however, one of the objects of the furnace engineer to compose his «Møller» or «Satz», viz. the quantity of ore and limestone with which the furnace is each time charged, so that he may do with as small a quantity of limestone as possible. The composition of the charge varies according to the chemical character of the ores and also according to the quality of iron to be produced.

Previously, when furnaces were smaller, the charge used to be mixed at the storage place; with the large modern furnaces that is not any longer necessary. The engineer gives his orders to the storage foreman who sends up accordingly so many pockets of this ore, so many of the other and so many of limestone, as I had seen at the storage sheds.



FURNACE HOIST.

At the new furnaces there were modern inclined hoists on the pattern which the Americans were the first to use; they run to the crest of the furnace at an angle while the older furnaces had vertical lifts. It was pointed out to me, how, by the new arrangement, not only could the work be done much more rapidly than before, but also quite automatically because the pockets were simply emptied into the lift waggon placed in an excavation below the floor on which the pockets were run, and the 3 to 6 men who at the old furnaces carried the contents from the lift waggon to the top were superfluous.

Walking along of the furnaces we reached the oldest one dated 1855. Even to an inexperienced eye it looked very clumsy as compared with the new ones, but when it was erected it had itself marked a vast improvement. We ascended the staircase leading to the top and found ourselves at a plateau on which we could walk from one furnace on to the others. From the «Gichtbühne» or top gallery we had a fine view over the town Oberhausen and the works. On one side was one of the coal mines of the company with the «Halde» or huge dump and on the other side the Gutehoffnungshütte slag mountain which has a larger extent than the island of Heligoland.

Until the middle of last century the blast furnaces were open and the gases were allowed to escape. After the invention by Watt of the steam engine the blast was produced by steam power; previously it had been worked by water power. But after it had been acknowledged that to let the gas escape was a great waste the furnaces have been closed, and, as I have explained, the gas is now used for driving the blast engine and its heat is used for heating the blast.

On the older of the furnaces which have still vertical hoists the charge must be filled into the furnace by manual labour, but in the new furnaces this work is done automatically by the attendant below who works the lift.

The furnace is continuously being charged, day and night, year after year, alternatively with coke — 5 to 8 000 Kg. — and with a charge of ore and limestone which also varies — between 10 and 18 000 Kg. As the coke and ore smelt in the «Gestell» the above lying quantities sink gradually downwards and each charge thus passes through the furnace in 12 to 24 hours.

Until the last third ot the 19th century only cold blast was used, but after the Englishman Neilson had recognised the advantage of employing heated blast and the Württemberg Bergrat Faber du Faur had discovered in the hot furnace gases a cheap heating fuel, only heated blast is nowadays used; the blast enters the furnace at a temperature of 700—900 ° C. The heating takes place in blast heating towers; these contain a network of canals made of fire proof bricks. The furnace gas is alighted and passes through the whole tower before escaping through the shaft; to each furnace there are at least four such towers. When the gases have passed for a certain time through one tower, a great part of the heat contained in the burning gas has been absorbed by the bricks; the gas is then turned on to the next tower, while the blast is sent through the heated tower, and, absorbing heat from the glowing bricks, it leaves the tower at a temperature of 700 to 900 ° C.

As the blast has a speed of 12 to 14 m. in the second it passes rapidly through the furnace; meeting in the Gestell glowing coke it burns with the coke to carbonic acid, CO_2, afterwards changing, owing to the preponderance of coke, to carbonic oxyd, C. O. Passing through the upper layers of coke and charges the gases give most of their heat to these, leaving the furnace at a temperature of 50 — 150 ° C.

The carbonic oxyd gass eagerly absorbs oxygen from the ore, burning with it to carbonic acid. As the masses gradually sink they become more and more heated and at 800 to 900 ° C. the iron begins to be reduced which takes place in about the middle of the furnace. A part of the carbon is simultaneously absorbed by the iron; an iron-carbon or pig iron is formed. The complete smelting of the iron, the smelting of the slags and the final reduction of the iron from the ore and the slags takes place towards the bottom of the furnace, the Gestell.

The iron being about 3 times heavier than the slags, these float on the top of the molten iron. When the slags have reached a certain height the slag hole, a little

GICHTBÜHNE OR GALLERY.

below the blast tubes, is opened and the molten slags run as a continuous stream to railway trucks of iron on a lower level and they are carried to the slag mountain.

When the Gestell was nearly full of iron — to just below the slag opening — a hole which had been closed with clay, was opened and the iron ran out — a glowing stream — through sandgroves where pig iron bars were formed. Sometimes the iron is run out in pans containing 40 tons which are transported by a railway to the «mixer» in the Thomas steel works. After the furnace has been emptied, the hole is closed again by a mixture of clay and fireproof bricks.

The output of the furnaces ranged between 250 and 500 tons pig iron every 24 hours. They are worked day and night without interruption; the workmen change the shift at 6 in the morning and 6 in the evening. To obtain the necessary change from day to night shift the workmen must every fortnight work 24 hours at a stretch from Sunday morning to Mondag morning. There is always a furnace engineer on duty.

THOMAS STEEL WORKS — CONVERTER ROOM.

The cokes are made in a number of air tight chambers — a so called battery —, in which the gases which are produced by the heating process are used as fuel. At the time of our visit one of these chambers was emptied by a machine ram at the back, and the glowing mass was instantly cooled by a copious sprinkling of water. The Ruhr coals yield in comparison with the coals of upper Silesia a very good coke. A number of valuable by-products such as tar, Ammonia, Benzol and a manure Ammoniaksalz are obtained from the gases. A number of chemical industries have been built up on these by-products as their raw material.

A large part of the pig iron is, as mentioned above, transported in big iron pans on specially constructed trucks in the molten state direct to a pig iron «mixer» in the steel works. This mixer was an enormous cylinder of thick iron plates lined with fire proof bricks which could hold 1000 tons of molten iron and which could be tipped. At the top it was heated by a burning mixture of gas and air to prevent the metal from freezing. By motions of the mixer the greater part of the sulphur contained in the iron is also absorbed by the Mangan in the pig iron and goes to slag.

Every 15 minutes a pan holding 23 tons and placed upon a massive railway truck was run underneath this mixer to be filled and from this pan again the Thomas convertors are filled.

Sir Henry Bessemer invented about the middle of last century the method for converting pig iron into forge iron or steel which bears his name. Essentially it consists in forcing a blast of air, through a number of fine holes in the bottom of the converter, into the molten metal; the oxygen combining with the silicium and mangan contained in the bath these are burnt, producing an enormous heat; after these have been consumed the oxydation of the carbon commences and when all the carbon has also been burnt the flame goes down and the process is ended. One may say therefore, that by this method the silicium and mangan contained in the raw iron is used as fuel and that the raw iron is converted into steel because these impureties have been burnt away. The Bessemer method made it possible to convert in 10 to 15 minutes the same quantity which it had previously taken 24 hours to refine by the puddling process. And it is due mainly to this invention that the iron production of the world has increased so enormously during the last 50 years. But the process did not do all that was expected from it; good phosphorfree steel could not be produced by the Bessemer process except from phosphorfree pig iron. And as Germany is poor in phosphorfree iron ores, the German steel works were obliged, when employing the Bessemer process, to import either phosphorfree iron from England or phosphorpoor ores from Spain.

The Englishmen Thomas and Gilchrist solved the problem, however, in 1878. By giving the converter a basic instead of an acid fire proof lining they so modified the Bessemer method that raw iron with a high percentage of phosphor and very little silicium is used. In the Thomas or basic process it is therefore the phosphor which is used as fuel and not the silicates.

The converter which rests on two axes through one of which the blast is introduced, was first turned down and filled with molten iron and an addition of limestone and was thereupon raised to a vertical position. The process which lasted about a quarter of an hour during which I was told that the temperature rose to some 1800 ° C. presents a most beautiful spectacle; under a thundering noise a firework of sparkling, glitter-

ing yellow red and green stars of burning particles are thrown out of the mouth of the converter. After the carbon had been quite burnt out a quantity of mangan iron or Spiegel was added to give the steel the required degree of hardness.

Now commenced what seemed to me the most interesting part of the whole operations. The contents of the converter was emptied after the slag had been run off into moulds, the so colled ingots, and when the contents had hardened sufficiently on the outside, a travelling crane moving high in the air came along and by an ingenious arrangement the operator was enabled to grip these white hot ingots as if by a hand of Vulcan and deposit them in narrow pits in the floor. These have a fire proof lining and

heating fuel is required from the molten raw iron leaves the blast furnace till the manufacture is completed, the intermediate stage, the Thomas process, even adding heat to the material. A very valuable by product Thomas Phosphat is obtained from the slags of the Thomas process.

Besides the Thomas converters we also inspected the large Siemens—Martin open hearth steel furnaces where quality steels are manufactured and we saw the manufacture of tyres going on as well as of wire.

The tour had taken nearly four hours and I was glad to follow my cicerone to his «Stammtisch» where we met a number of the officials and spent an hour very agreeably discussing the iron and steel trade in general and the Gutehoffnungshütte in special.

STORAGE OF MINING RAILS WITH TRAVELLING CRANE.

as soon as an ingot was deposited in this pit, the hand-like arm of the travelling crane put the lid on; it was quite uncanny to observe how very closely the action of the machine resembled the movements of the human hand. In this pit the interior of the ingot soon hardens sufficiently to permit of its being subjected to the rolling process. Again comes the hand of the machine, removes the lid and takes the ingot in its firm grip to place it on a sort of a craddle at the top of the rolling plant from which it was toppled over and slided down to the rolling plant.

At one heat this ingot was thereupon rolled forwards and backwards and all which the attendant had to do was to shift his handle from time to time; the block of iron was then shifted automatically from one side of the roller on to the other, as required. The strips were removed, also by automatic arrangements, from one set of rollers to another and finally emerged from the process as finished rails. Thus no

Nowadays it is difficult to explain to laymen the difference between iron and steel. The book: Gemeinfassliche Darstellung des Eisenhüttenwesens, published by the Verein deutscher Eisenhüttenleute gives the following explanation: «steel» and «forge iron» cannot be strictly defined; the smelting point of the former lies between 1380 and 1400 ° C., of the latter between 1450 and 1500 ° C., and steel should have the quality of hardening on rapid cooling. But nowadays so many qualities are produced that the name «steel» or «iron» depends to a large extent upon the whim of the producer, and practically all material which has a stretching strength of 50 Kg. pr. 1 mm. square is reckoned as steel.

Having seen iron ore being loaded at Narvik, of which large quantities are used by the Gutehoffnungshütte as well as by other iron works of this district, I have now been enabled to follow the ore, afterwards

the iron and steel through the many complex processes of manufacture until the finished rail, railway tyre or bundle of wire is ready for shipment.

As I have stated above the Bessemer process was not well suited to the ores which the German iron works principally employ; it was the invention by Thomas and Gilchrist of the Thomas process that gave the German iron industry its great chance. The German pig iron production was 975 000 tons in 1865

3 687 000 — 1885

5 465 000 — 1895

12 478 000 — 1905

In 1902 it was equal to, in the following four years it exceeded the output of Gt. Britain.

Of the steel works which are members of the Stahlwerksverband the Gutehoffnungshütte has a Betheilungsziffer (or producing capacity) of 600 000 tons steel. The firm commenced making Bessemer steel in 1872, Thomas steel in 1882 and Siemens—Martin steel in 1879.

Afterwards I visited also the Sterkrade Branch, steel casting, engineering and bridge building works.

At this place the proprietors commenced almost from the beginning to manufacture steam engines and other kinds of mining machinery, at first on English patterns and partially with the assistance of English draftsmen, but soon the management began to work on independent lines.

The bridge building department was started in 1864; it has built many large bridges in almost every country of the world.

Space forbids going in detail with regard to this branch, but I take the followlng paragraf from the Jubilee publication of the company:

«The Sterkrade branch has been lucky enough to have had managers who have always been broad-minded enough to find new fields for enterprize and new markets. The Gutehoffnungshütte has always made full use of technical progress and has also in their special branches of engineering and bridge construction been a leader of technical progress. Even in periods of depression technical science and technical investigation have here found a home, although the advantage of this research work could not always be demonstrated as profit. To this day the engineering and bridgebuilding works of this firm hold a leading position among the best German works, and their productions have created the fame which the name Gutehoffnungshütte enjoys in the Fatherland and in the World's markets.»

Messrs ABR. & GEBR. FROWEIN,

ELBERFELD

In Elberfeld there are a number of old established firms; the above house was established in 1763.

The office and works are contained in a big building of 5 stories, with large sheds for the looms at the back.

At the top was the «Winderei» and the department for Besatzartikel or trimmings for ladies which were made of artificial silk with «Häckelmachines»

Through three stories there were on both sides of the staircase weighing rooms where the material was given out and the finished work critisized and received from about 400 home workers who are employed by the firm.

In the weaving shed there were 165 mechanical ribbon looms. In such a loom 20 ribbons are manufactured simultaneonsly; a ribbon may contain as many as 1 600 yarns in the kette or warp. The weft is thrown in by a most curious arrangement of shuttles, running automatically in semi-circular groves. I tried in vain to observe the yarn during the process of weaving; it was so fine that I could not see it.

The firm employs at the factory 600 labourers in addition to the 400 home weavers who now largely use electric power for their looms.

The firm produces:

silk ribbons for gents' hat,
silk ribbons af every kind for ladies' use,
woolen Litzen,
» Spitzen or lace

and nouveautées in Besatzartikel for ladies.

The entire building was filled with ribbons in every variety of colours, quality and width. I wondered how on earth so many ribbons can be used, but the firm finds an outlet for their products every where. I saw parcels marked in Chinese characters, parcels with Argentine names, parcels for Norway, Sweden, Denmark, for England and France &c.

There are six partners, all lineal descendants in the 3rd or 4th generation from the founders, and the firm is as actively pushing its trade now as the pioners did 150 years ago.

There is a curions department of this firm of silk manufacturers; they carry on the second largest wine ausiness of the town. This was originally commenced because they obtained wines from friends in Spain which they sold for the use of invalids. But after a while this business was extended to comprise all classes af wine; I was allowed to go over their large cellars and to sample their Rhine wines.

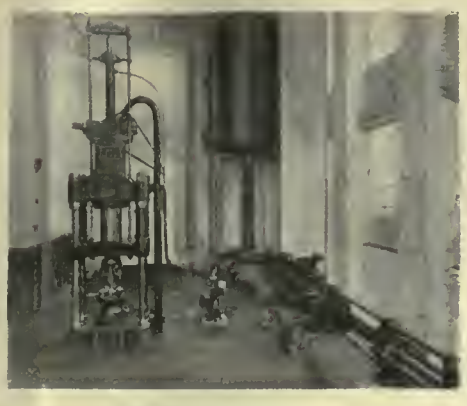
HYDRAULIK G. m. b. H.

DUISBURG

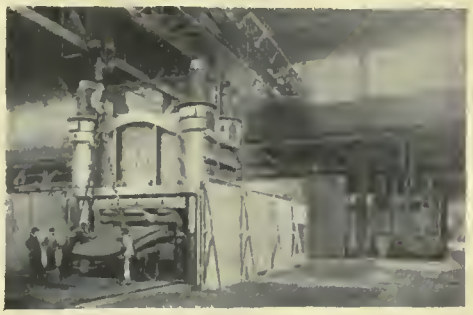
This company, although quite young in the Rhine Provinces, being founded in 1909, is in reality of older date, because this company is a combine of the hydraulic departments of the famous firm of A. Borsig, in Berlin, and Bechem & Keetman, Duisburg (now Deutsche Maschinenfabrik A.-G.) and these firms, especially Borsig, have for years been the most prominent builders of hydraulic machinery of all kinds, as presses, pumps and accumulators etc. The stock capital is only 600000 Marks, and the only share holders are A. Borsig and Deutsche Maschinenfabrik A.-G. The „Hydraulik" designs and sells the machines and have them built either by A. Borsig or Deutsche Maschinenfabrik A.-G. The chief reason for this combine was the necessity to be more in the center of iron industry of Continental Europe, as Berlin proved to be somewhat out of center, and the freight of goods was too high to compete succesfully with Deutsche Maschinenfabrik A.-G. and others. The latter desired to increase their hydraulic business and as Borsig possessed superior designs, the Deutsche Maschinenfabrik A.-G. or Bechem & Keetman as it that time was, readily agreed to Borsig's proposal for a combine.

The Hydraulik employes about 50 people or which more than half are Mechanical Engineers and specialists on hydraulic machinery.

The Hydraulik possesses a large number of patents among others for a press to extrude copper and brass tubes, a process that for years has been aimed at by many Engineers, but only recently realized. The forging presses and the projectile presses of the „Hydraulik" are to be found in the most prominent works and arsenals throughout Europe and the following page show a few illustrations of this kind of machinery.

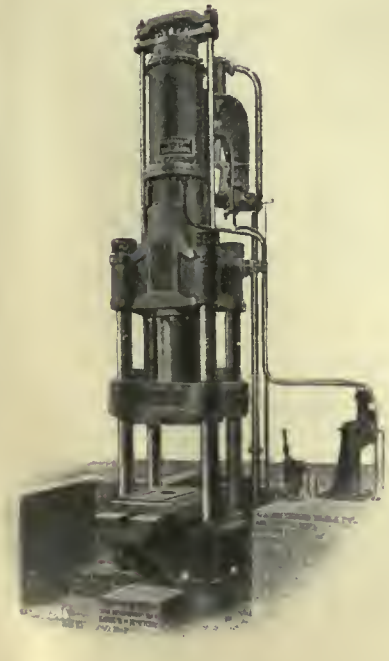


HYDRL. PRESS PLANT
FOR THE MANUFACTURE OF „SHRAPNELS"

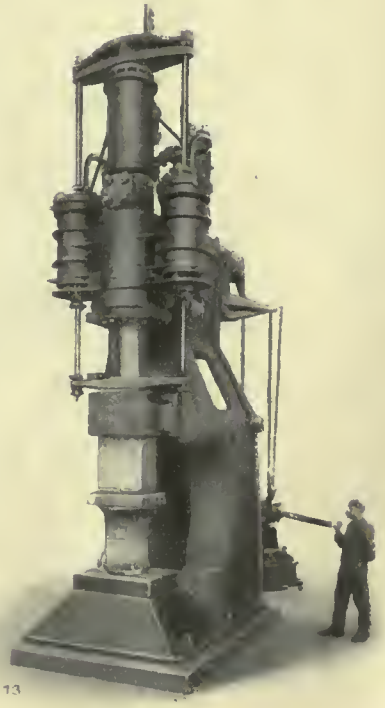


ARMOUR PLATE PRESS

HEAVY FLANGING PRESS



PURELY HYDRL. FORGING PRESS „EXTRA RAPID"



STEM-HYDRL. FORGING PRESS

Messrs SCHLIEPER & BAUM,

ELBERFELD

This firm was established as Calico printers in . It soon became the largest firm in this branch on the Continent which position it still easily maintaines.

Their head office is in Wupperstrasse in the middle of the town, and originally all the many manufacturing processes which calico printing entails were carried on in the works which surround the offices. But the water in the river has become to an increasing extent contaminated and it has been found necessary to acquire new land at a distance of about 10 Km. above the town where a new works has been built, although this necessitates the sending of the goods forward and backward at different stages of the manufacture.

I was received by Dr. Schlieper who explained to me that the textile industries had originated in Elberfeld with bleaching, because of the softness of the water in the river Wupper. The town celebrated in 1910 its threecentenary jubilee as a city, but the industries of the place are even older. The industrial activity of Elberfeld is very varied, but the textile trade is the most important.

Dr. Schlieper showed me their printing rooms where printing presses are in operation, and I had occasion to admire the many beautiful and varied designs.

The manager of the engraving department explained to me how the printing rolls are produced. The design is first engraved by hand on a small steel cylinder which is thereupon hardened, and this being pressed in a machine with great pressure against another and larger cylinder of soft steel, the design is transferred to this in high relief. The second cylinder is again in turn hardened and is used for transferring the design to the copper rollers. The machinery for preparing these is so finely constructed that an exactitude within one tenth of a millimeter may be obtained.

The firm which does busines all over the world employs 1 100 labaurers and 70 officials. Mess.rs Schlieper & Baum give a pension after 25 years service to those of their employees who are not any longer able to earn a living; their pension bill runs into Mk. 50 000 pr. annum.

Dr. Schlieper said that the trade unions had forced wages to high, that the industries of the town had a hard struggle for their existence, cotton spinning could not be carried on, and it was also difficult to make cottan weaving profitable. But in his own branch of industry so much depended upon hereditary capacity for the work, that his firm had been able not only to maintain, but to increase their turnover.

Centralbanken for Norge

Capital und Fonds

Kr. 3,000,000,—	bar eingezahlt
„ 7,500,000,—	eingezahlt in Staats-, Hypothek- und Kommunal-Obligationen, welche gemäss § 4 der Statuten bei der Norges Bank hinterlegt sind. (Der gesamte Nominalbetrag dieser Wertpapiere war per 1. Januar 1911 Kr. 7,946,154.99)
„ 3,470,000,—	eingewonnener Reservefond
zusammen Kr. 13,970,000.—	per 1. Januar 1911.

Besorgt Inkassationen und sonstige Bankgeschäfte aller Art

zu billigsten Bedingungen.

Tarife werden auf Wunsch bereitwillig zugestellt.

Christiania, Norwegen.

GENERAL LIBRARY
UNIVERSITY OF CALIFORNIA—BERKELEY
RETURN TO DESK FROM WHICH BORROWED
This book is due on the last date stamped below, or on the date to which renewed.
Renewed books are subject to immediate recall.

11Jun'54DA
JUN 2 1954 LD

LD 21-100m-1,'54(1887s16)476

DI SKE

E

172

Y

ddress:

A. B. C
Al, We i, Hongkong.

Branches:

Thoresen & Co., Shanghai.

China General Engineering Co., Shanghai.

Thoresen & Co.
(late Aagaard Thoresen & Co.), Hongkong.

Exporters of
Goods & Machinery to Oversea Markets.

Chartering and Sale of Steamers & Whalers.

PAMPHLET BINDER
Manufactured by
GAYLORD BROS. Inc.
Syracuse, N. Y.
Stockton, Calif.

M315179